SEPTEMBER 4, 1959

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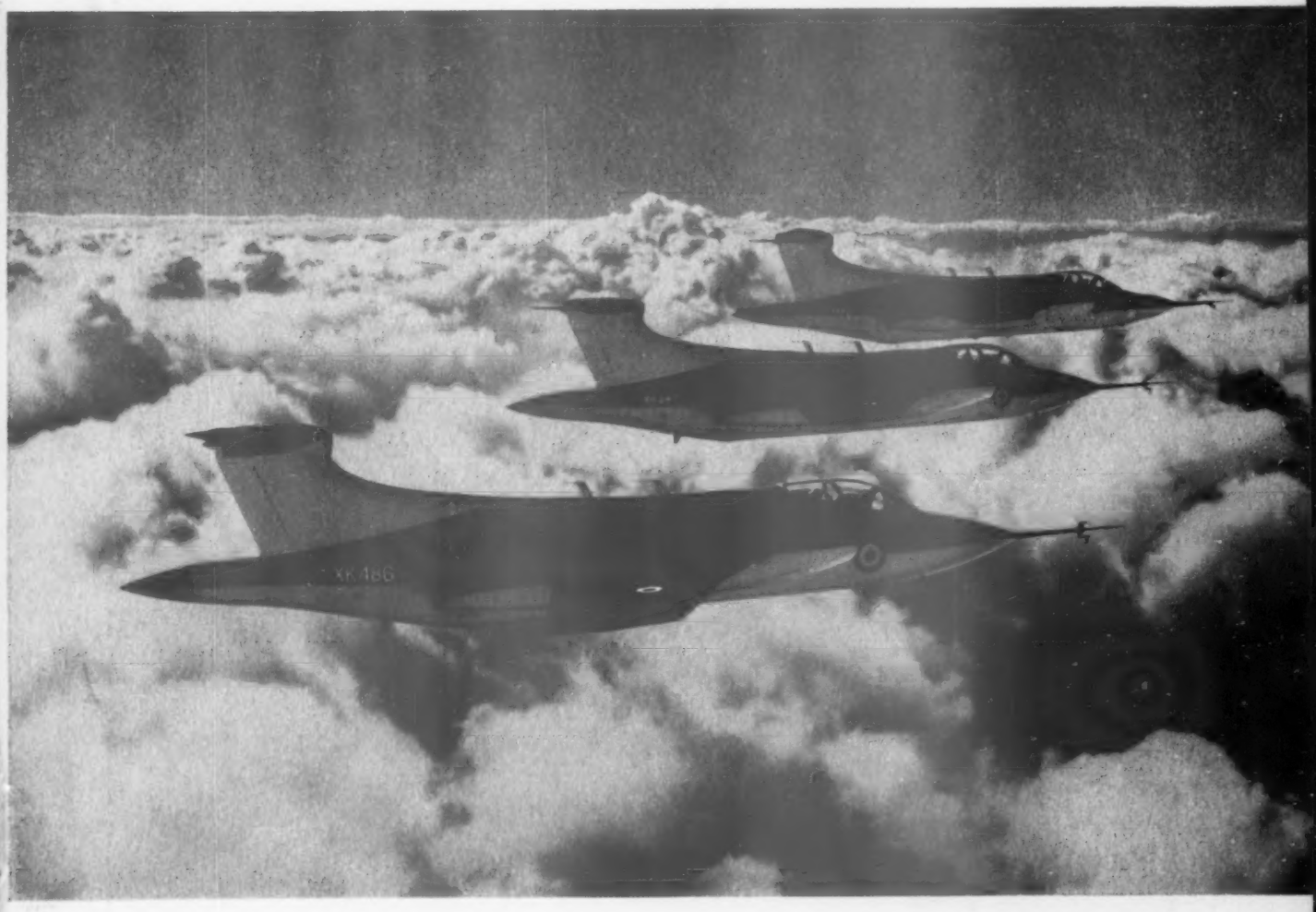

The NA.39 is ahead . . . *

Unique because it is the only aircraft in production specifically designed to withstand the rigours of high-speed, low-level flying, the NA.39 has great strength and stiffness as well as an engineered long operating life.

Area rule, which smoothes out the ride for the crew, and boundary layer control over the entire span, to provide outstandingly good handling and control during take-off and landing, were incorporated into the basic design.

A high-speed aeroplane flying at low-level, needs the most advanced systems for navigation and to ensure the precise delivery of its conventional or nuclear weapons. The NA.39 has them. That is why the Ministry of Defence has stated

* "*In the low-level strike role, the NA.39 is ahead of any other aircraft in the world.*"

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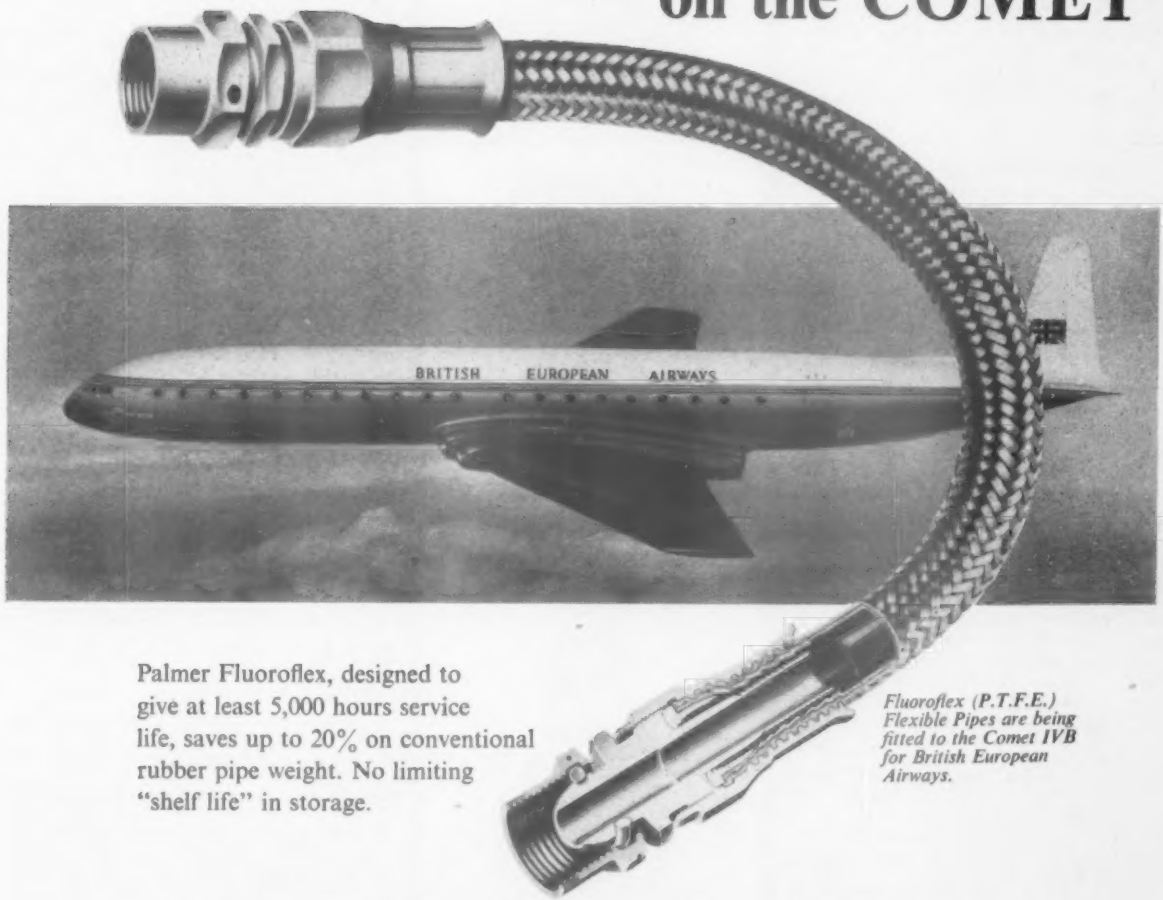
The TEST RESULTS that placed Palmer Fluoroflex on the COMET



Palmer Fluoroflex, designed to give at least 5,000 hours service life, saves up to 20% on conventional rubber pipe weight. No limiting "shelf life" in storage.

Fluoroflex (P.T.F.E.) Flexible Pipes are being fitted to the Comet IVB for British European Airways.

Palmer Fluoroflex Flexible Pipes have successfully withstood the following rigorous tests:

TEST 1

(a) Simultaneous Impulse and Vibration.
Pipe sizes −4 ($\frac{7}{32}$″ bore), −6 ($\frac{1}{16}$″ bore) and −8 ($\frac{7}{16}$″ bore).

IMPULSE: 600,000 cycles at 100 cycles/min. to peak pressure of 3,800 p.s.i. Rate of pressure increase 126,500 p.s.i. per sec.

VIBRATION: Amplitude ± .005″ at 7,500 cpm frequency.

TEMPERATURE: 120°C. internal and ambient.

(b) Continuation of test for 900 hours at static pressure of 3,000 p.s.i. and normal ambient and internal temperature.

TEST 2

(a) Simultaneous Impulse, Vibration and Flexing
Pipe sizes −4 ($\frac{7}{32}$″ bore) and −6 ($\frac{1}{16}$″ bore).
Impulse as in Test 1.

VIBRATION: Amplitude ± .020″ at 3,000 cpm. frequency.

FLEXING: 4″ for 20,000 cycles and 9″ for 40,000 cycles.

TEMPERATURE: Normal for 99 hours, −55°C. for 8 hours.

(b) Continuation of test for 900 hours at static pressure of 3,000 p.s.i., normal internal and ambient temperatures and without flexing.

The above tests each correspond to 10,000 hours factored life on the hydraulic system of the De Havilland Comet IVB.

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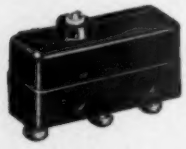

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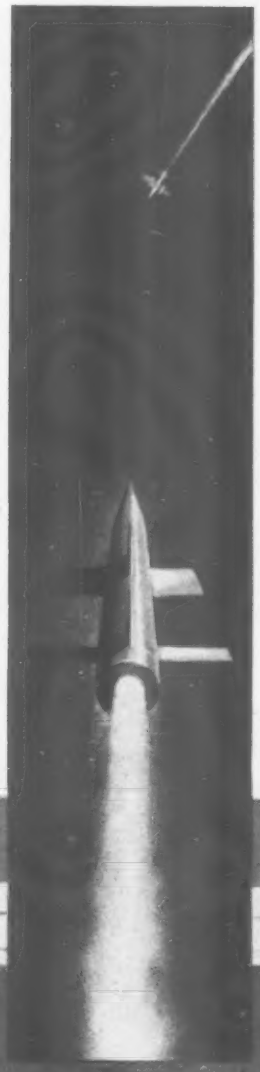

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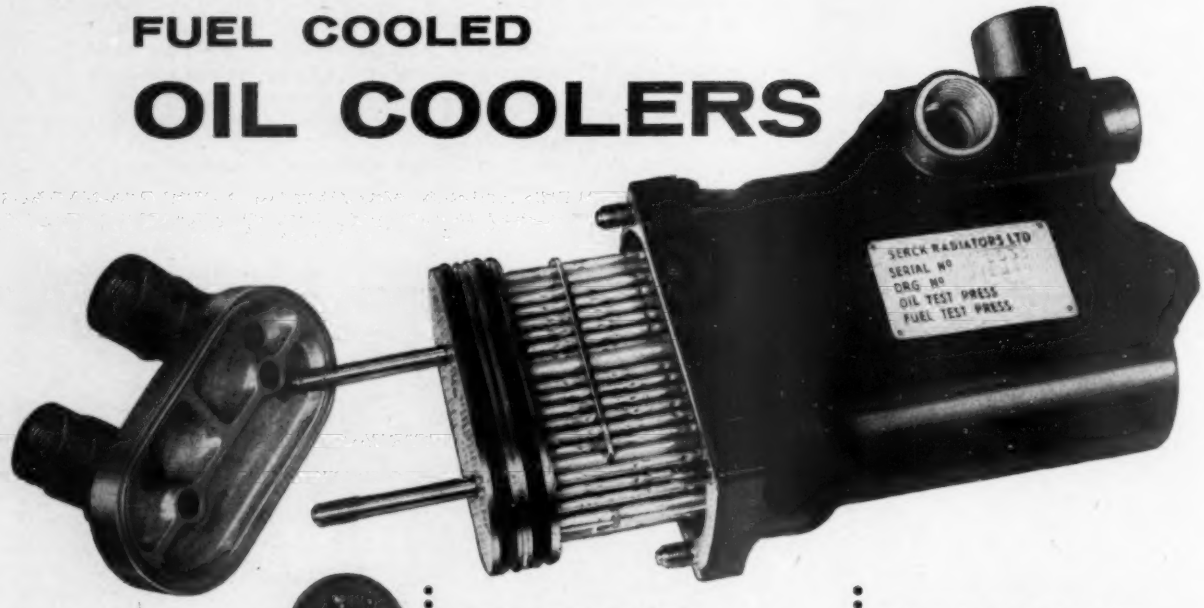

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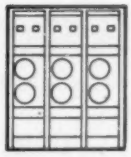

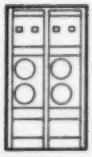

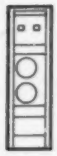

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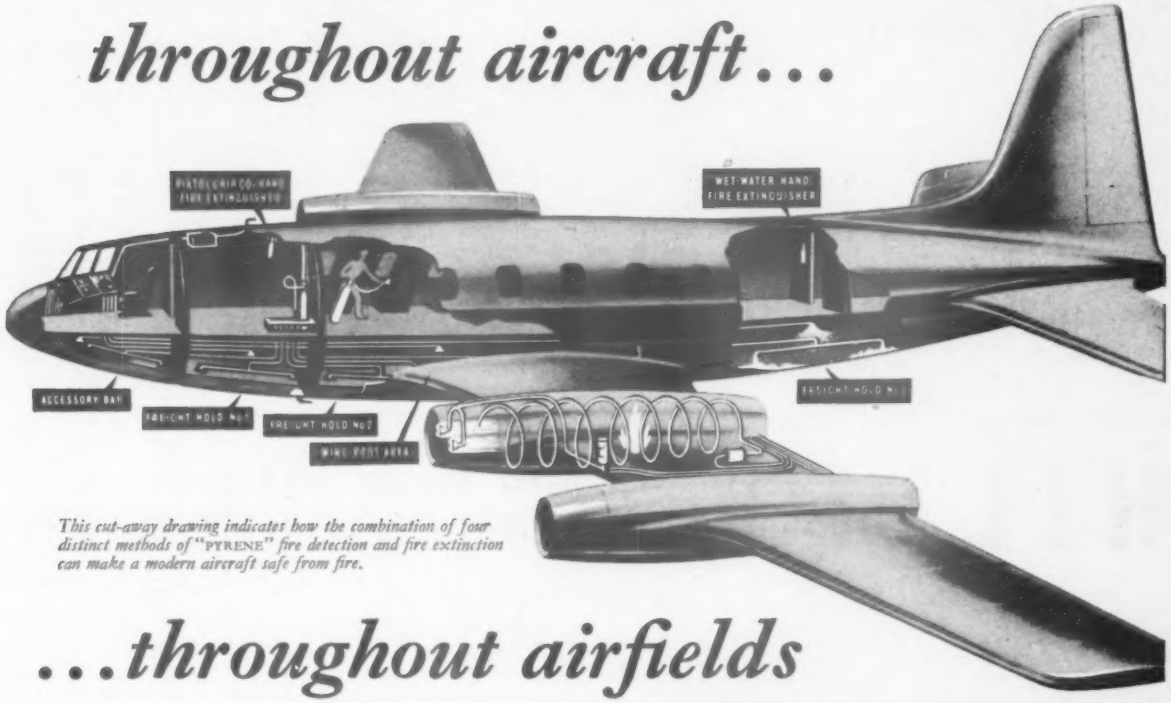

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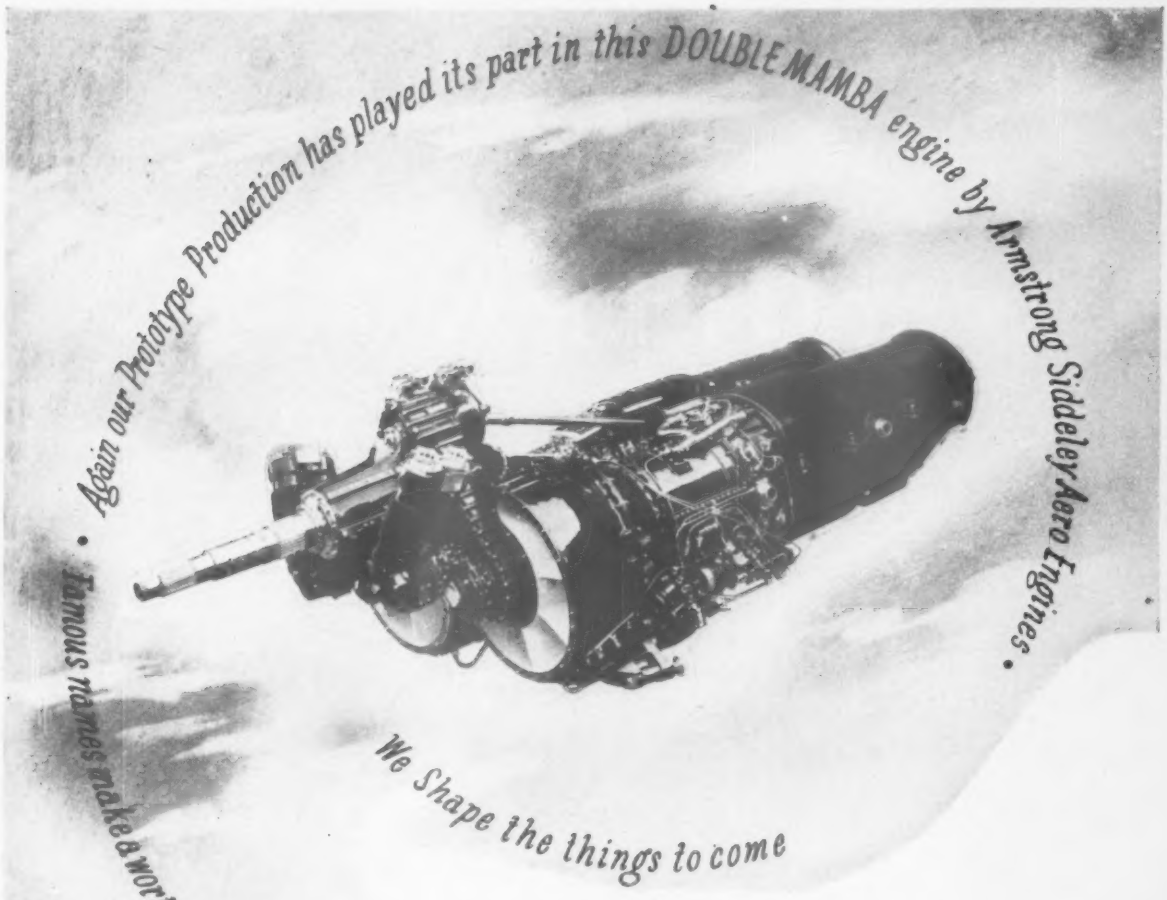
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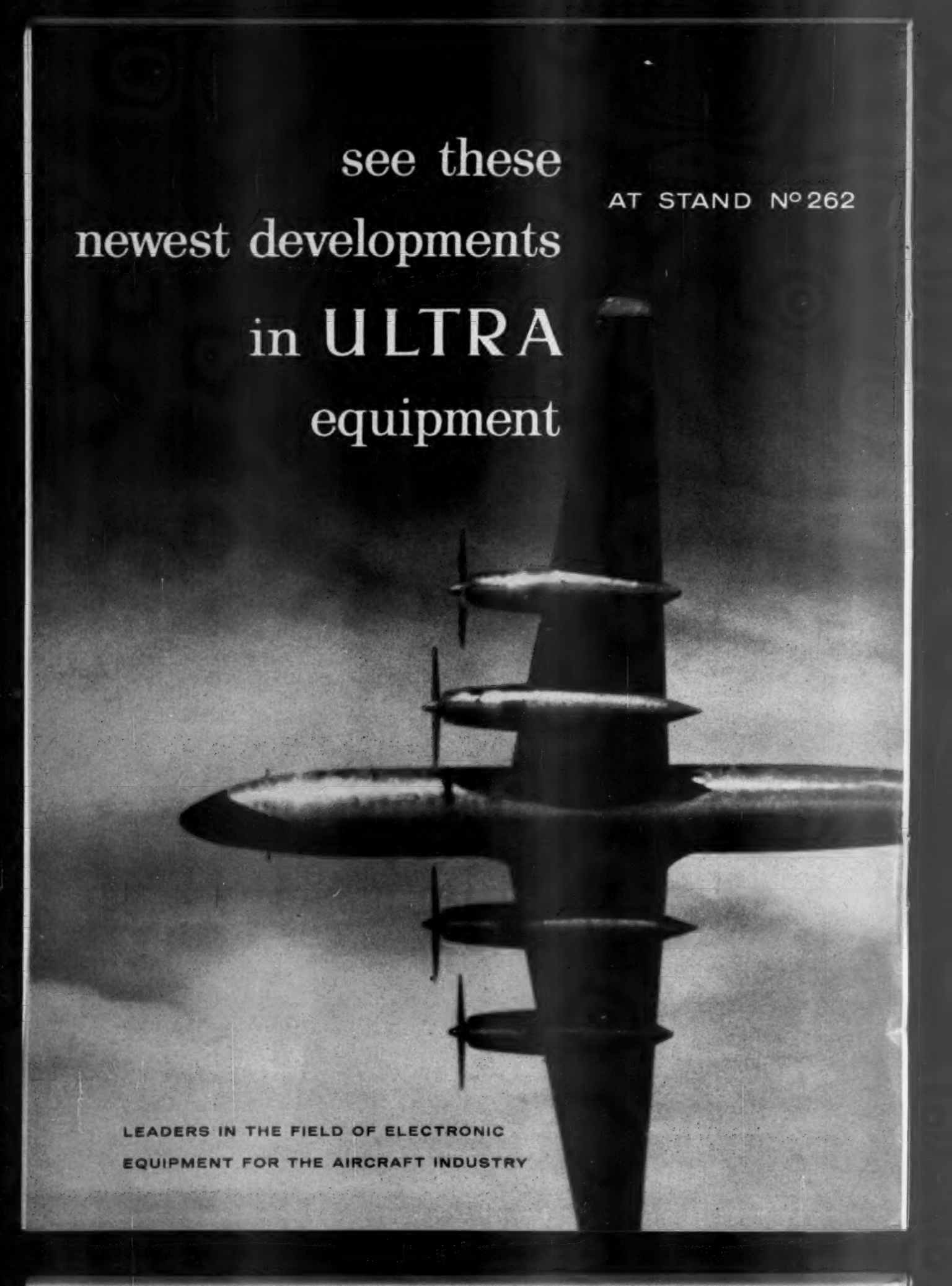
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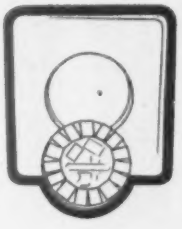

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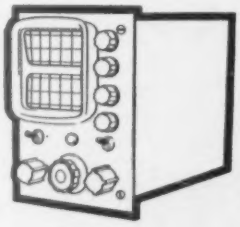

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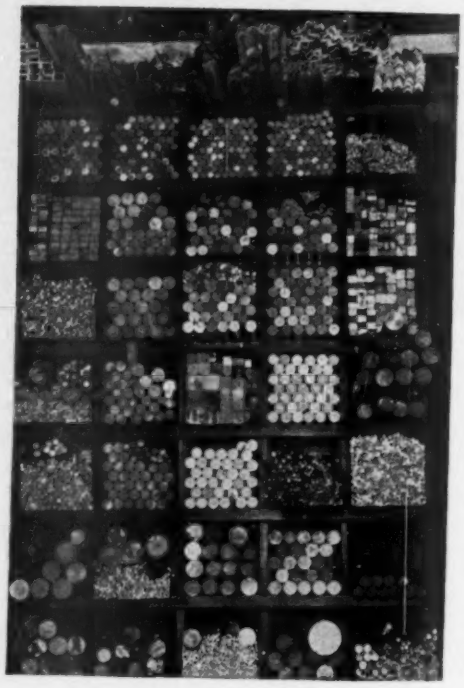

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The Fokker F-27 is also built under licence by Fairchild Engine and Airplane Corporation U.S.A.

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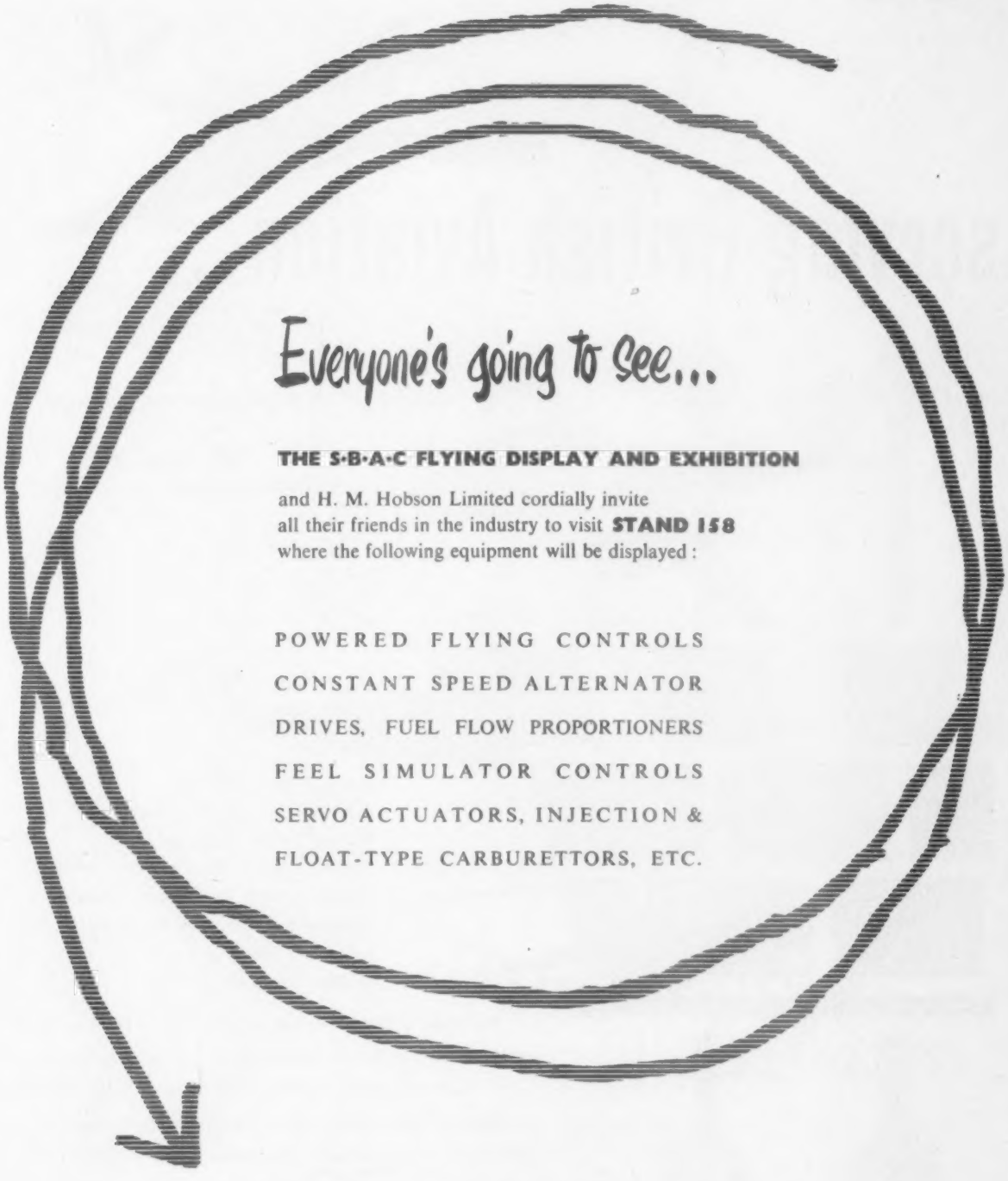

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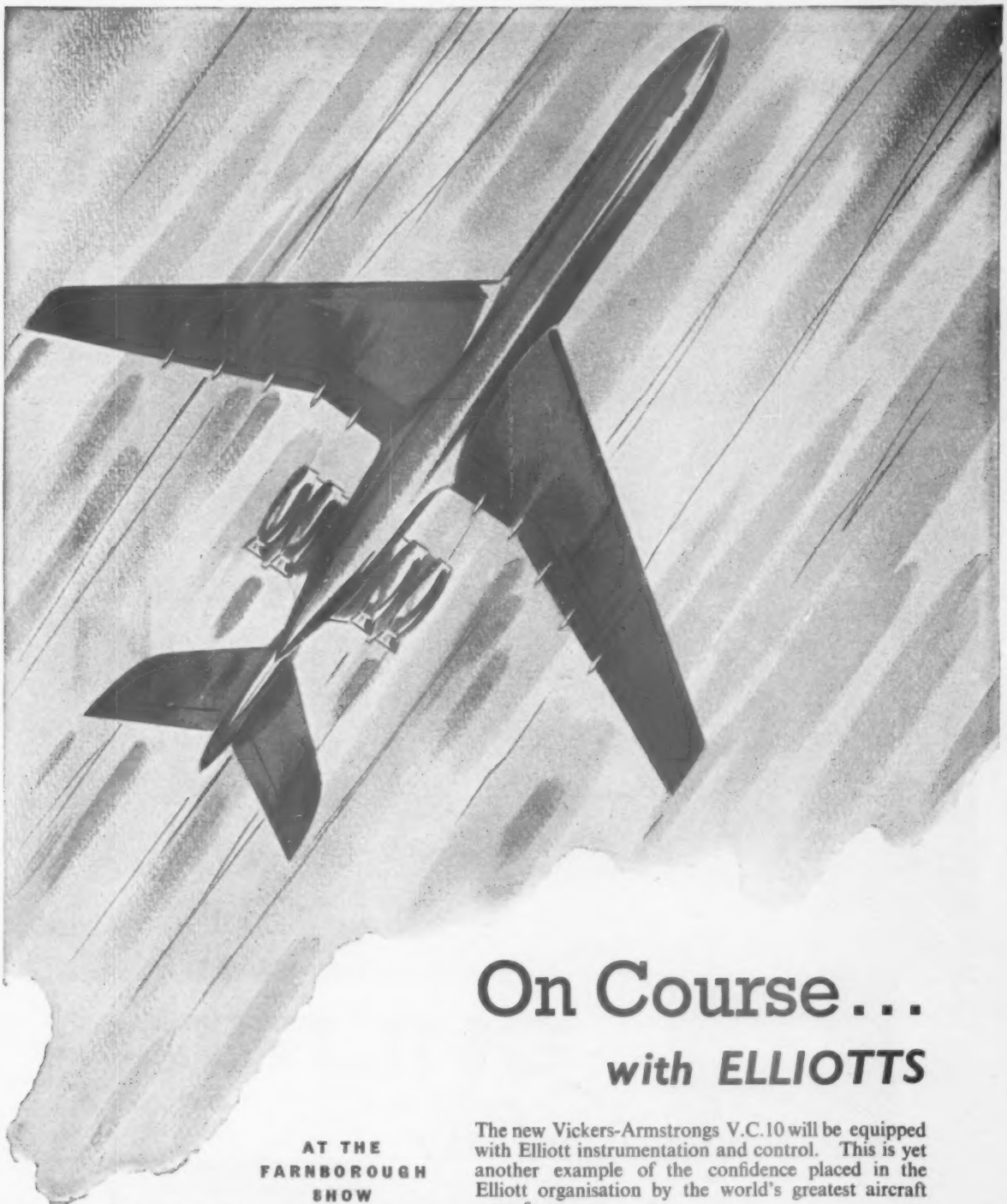

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with ELLIOTTS

The new Vickers-Armstrongs V.C.10 will be equipped with Elliott instrumentation and control. This is yet another example of the confidence placed in the Elliott organisation by the world's greatest aircraft manufacturers.

On stand 218 (Elliott' Aviation Division) at the Farnborough show, a large-scale model of the V.C.10 will be on view demonstrating the application of the Elliott control system to this new all-jet aeroplane. Also on this stand the latest Elliott Central air reference system, electro-hydraulic servo systems, transistorised voltage regulators and a turbine engine analyser will be shown.

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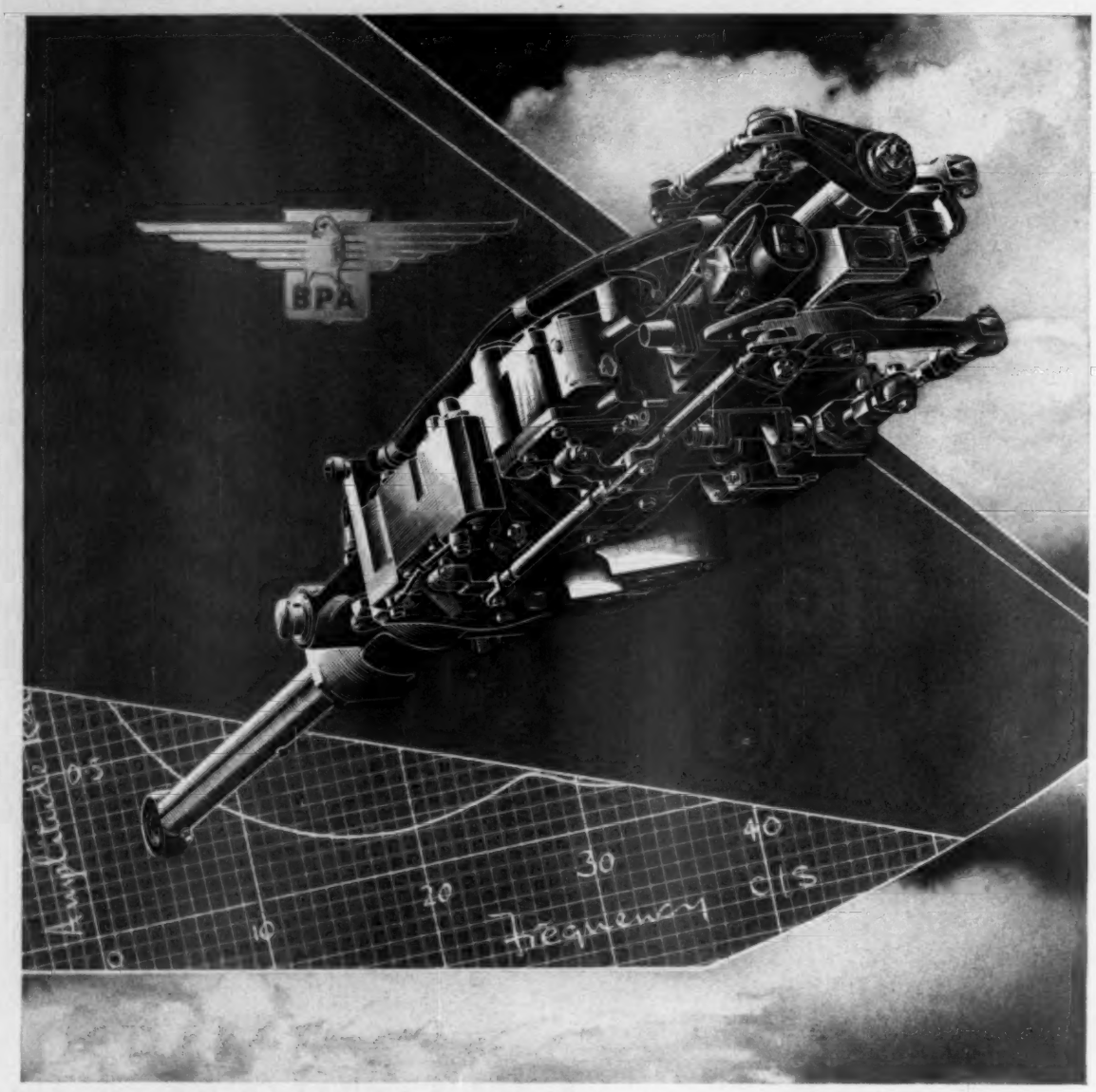

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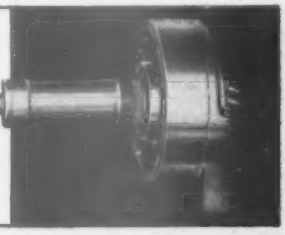

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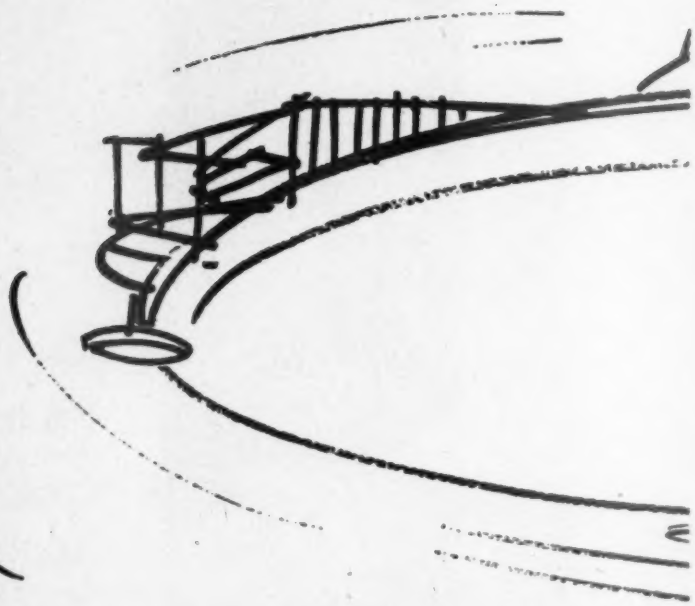

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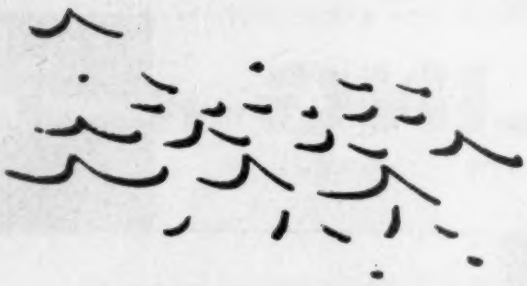

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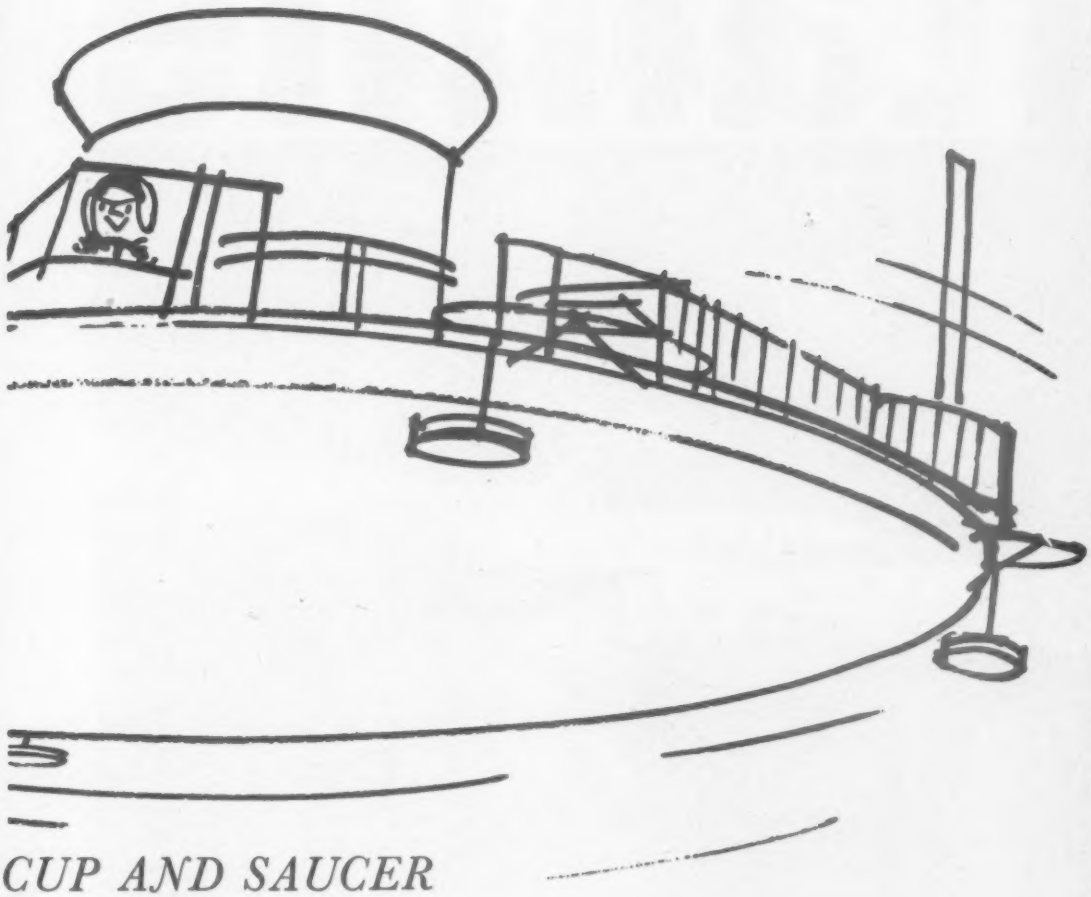

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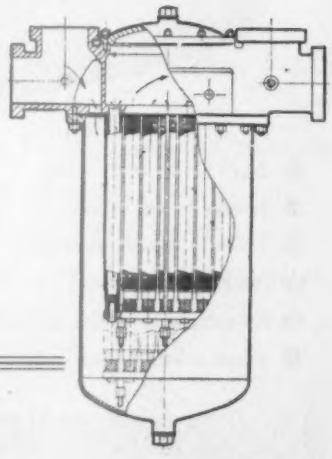

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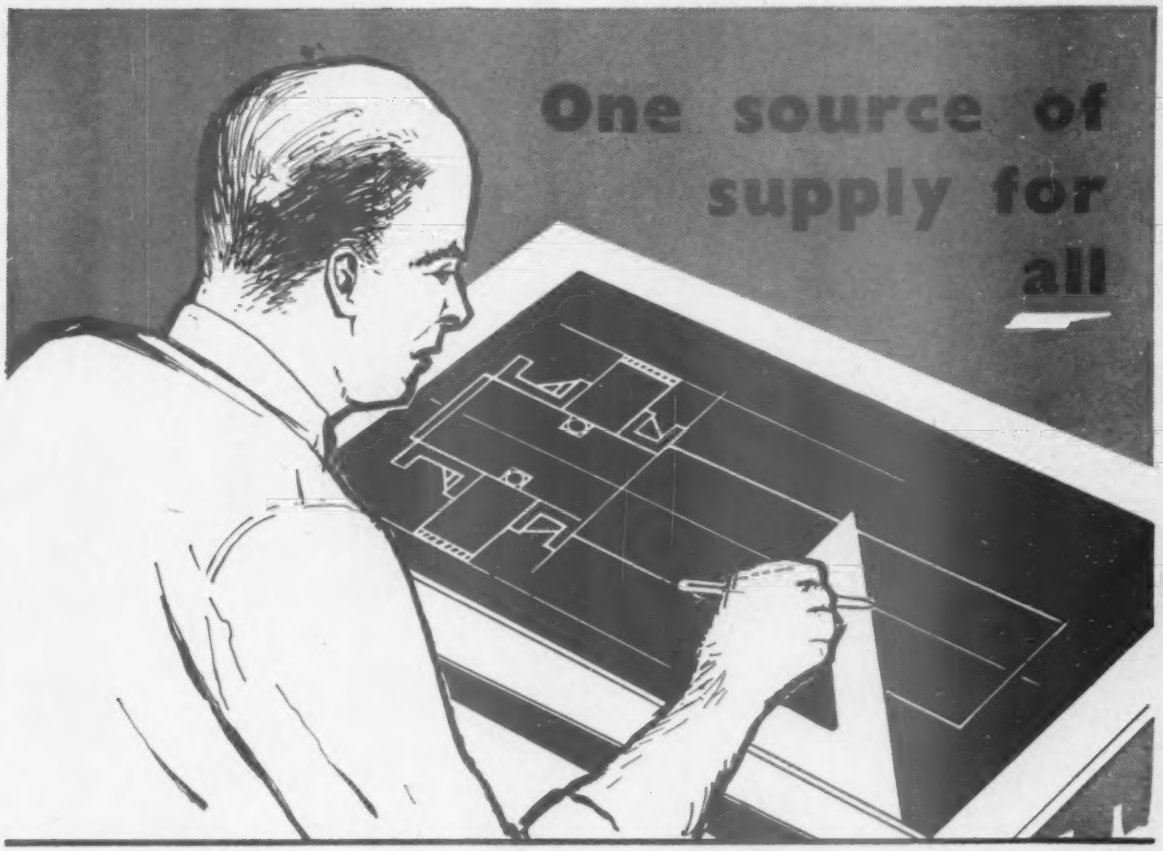

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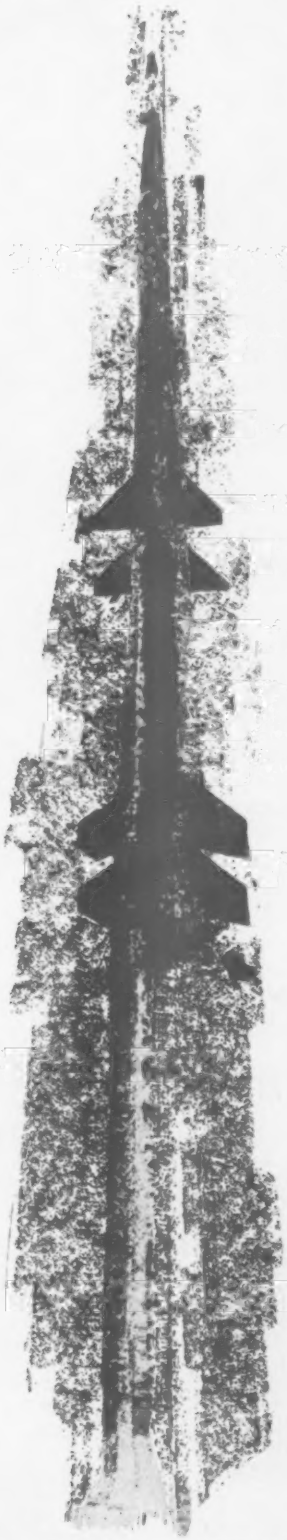

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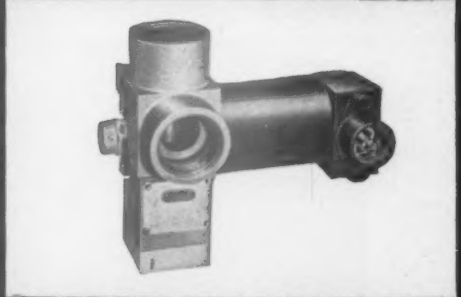

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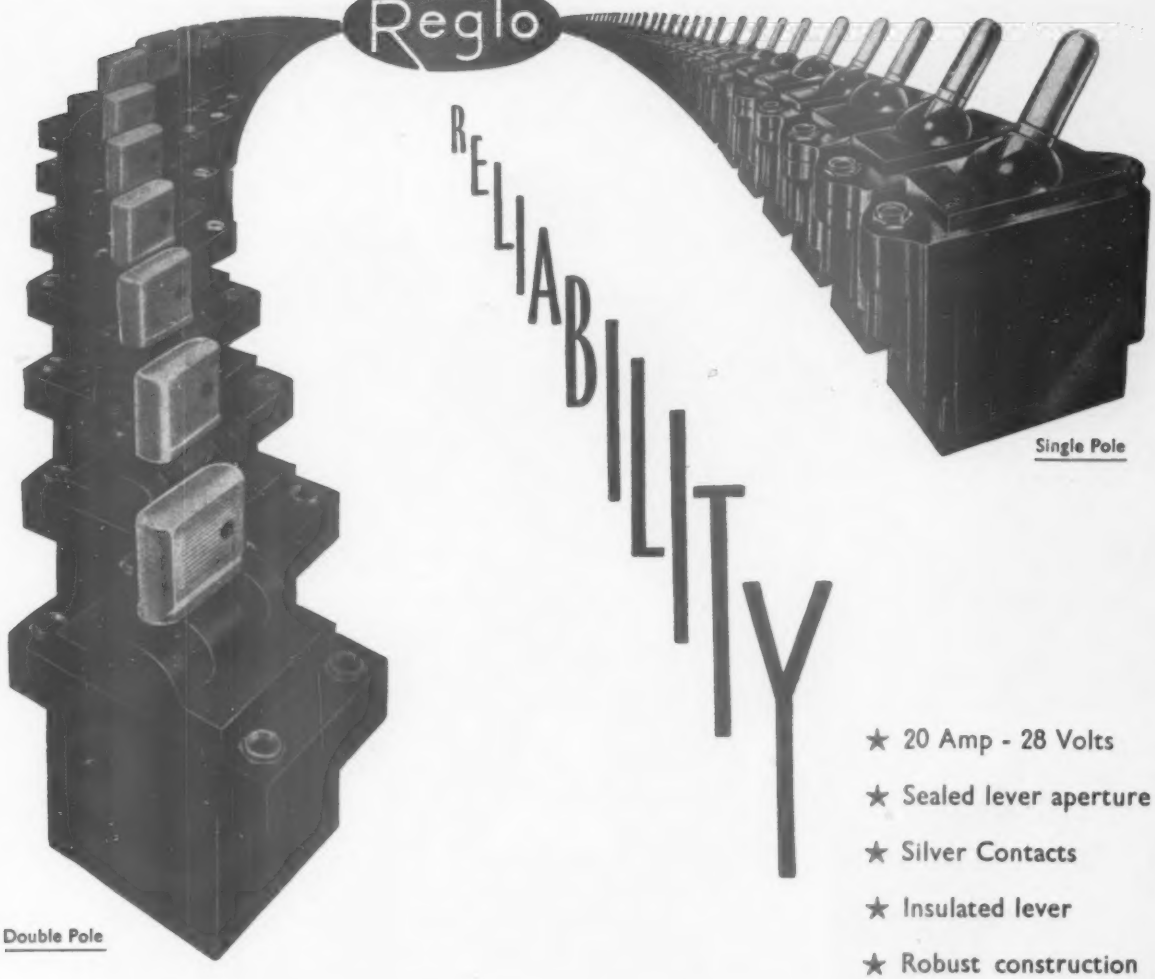

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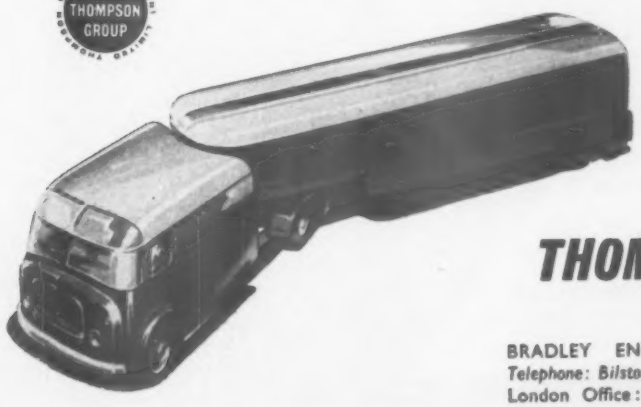

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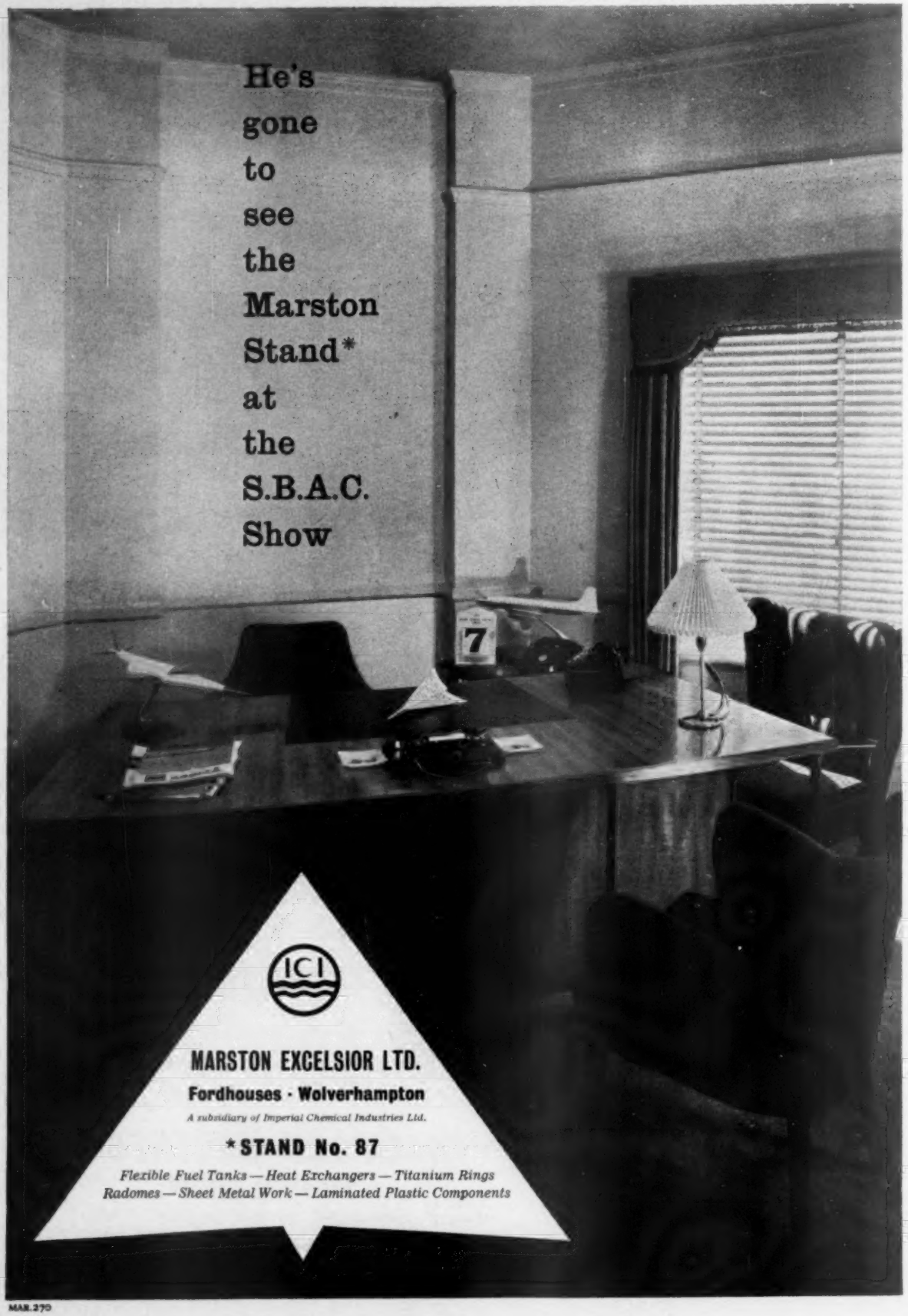
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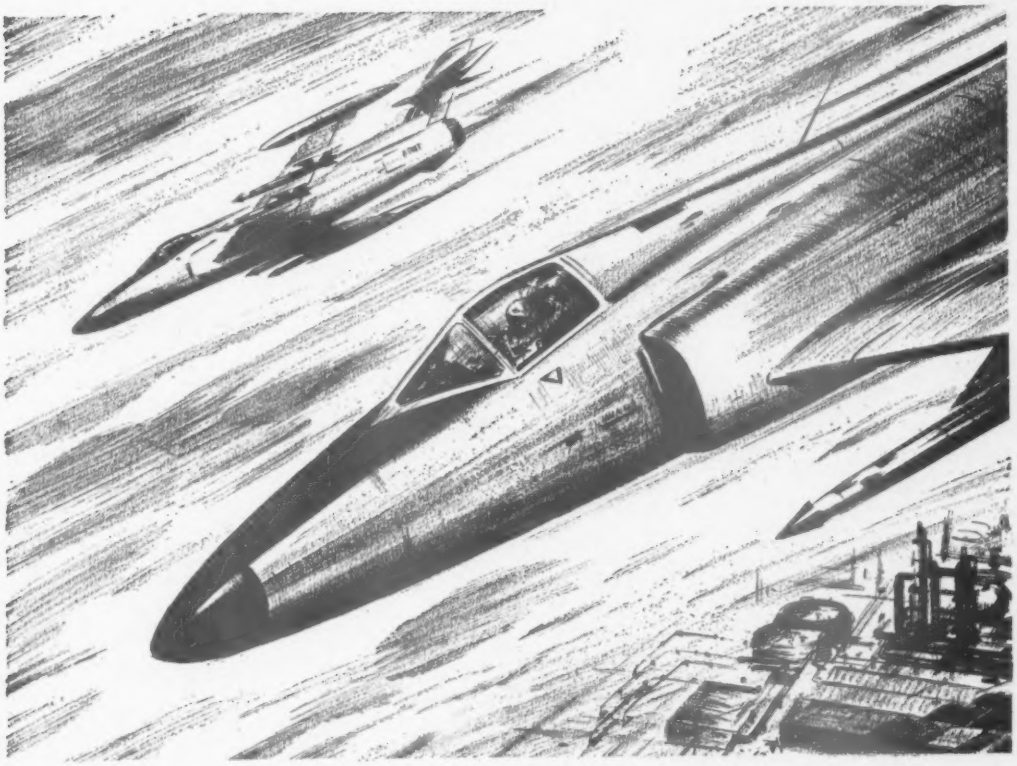

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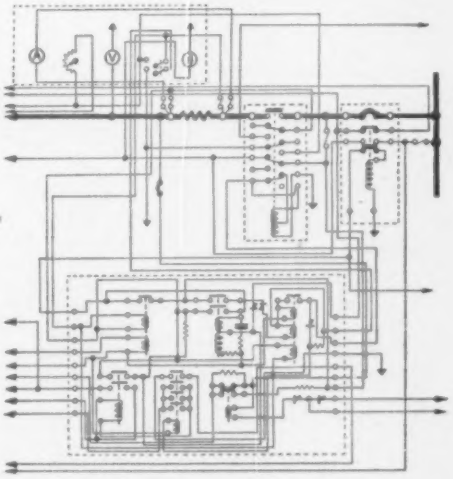

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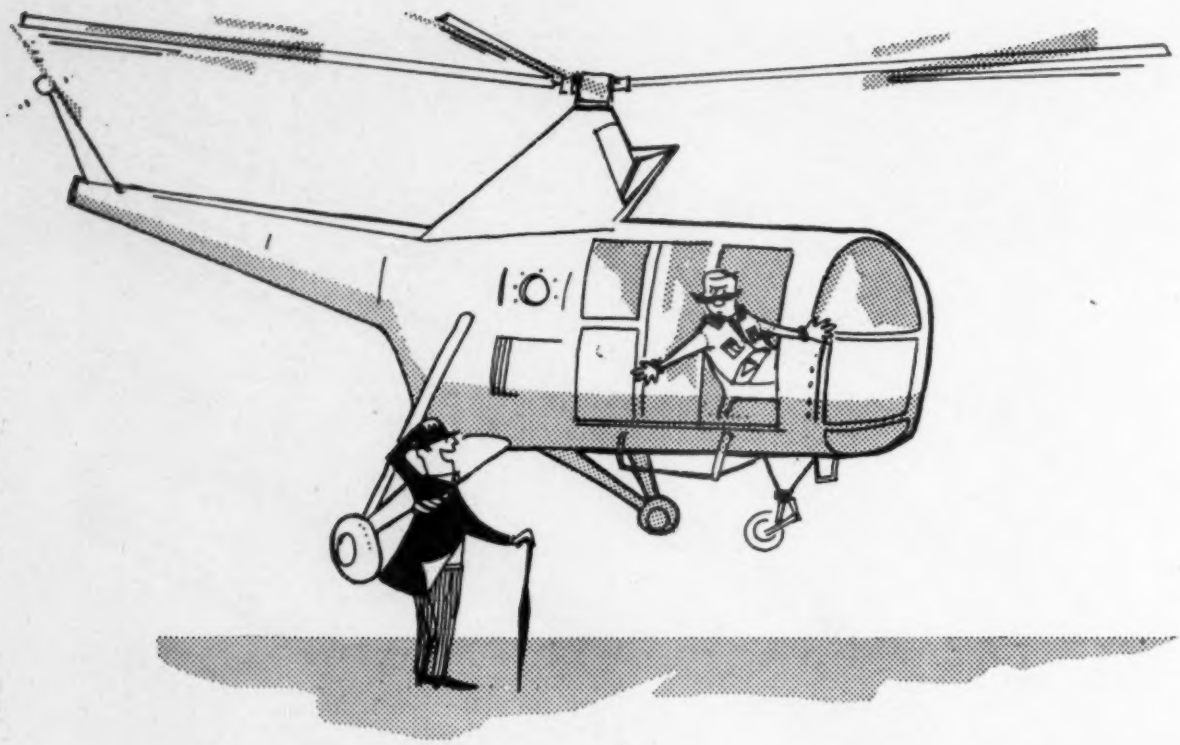

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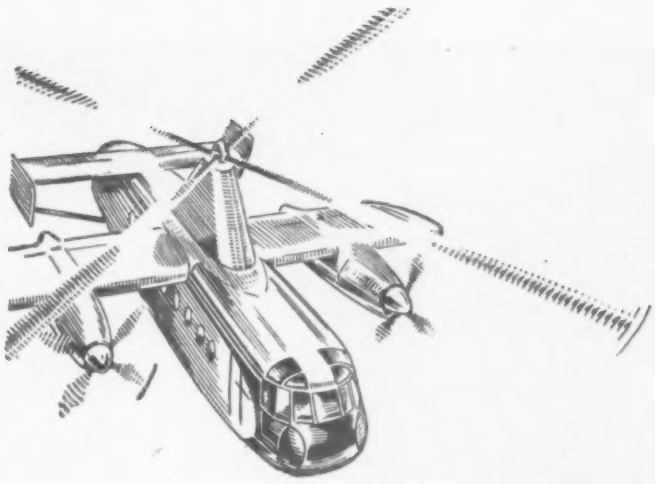

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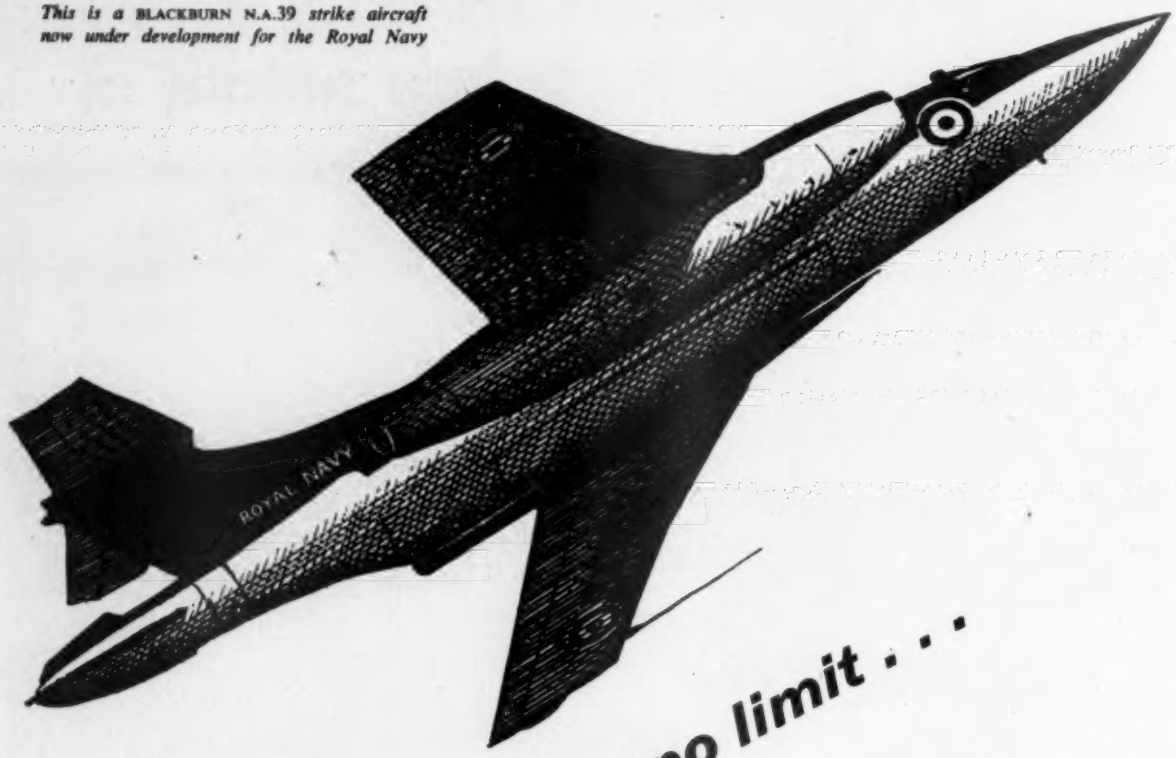

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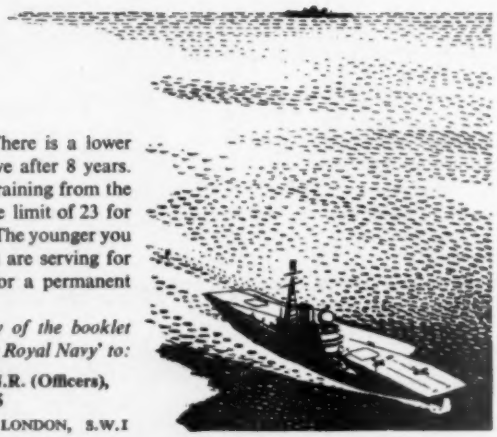

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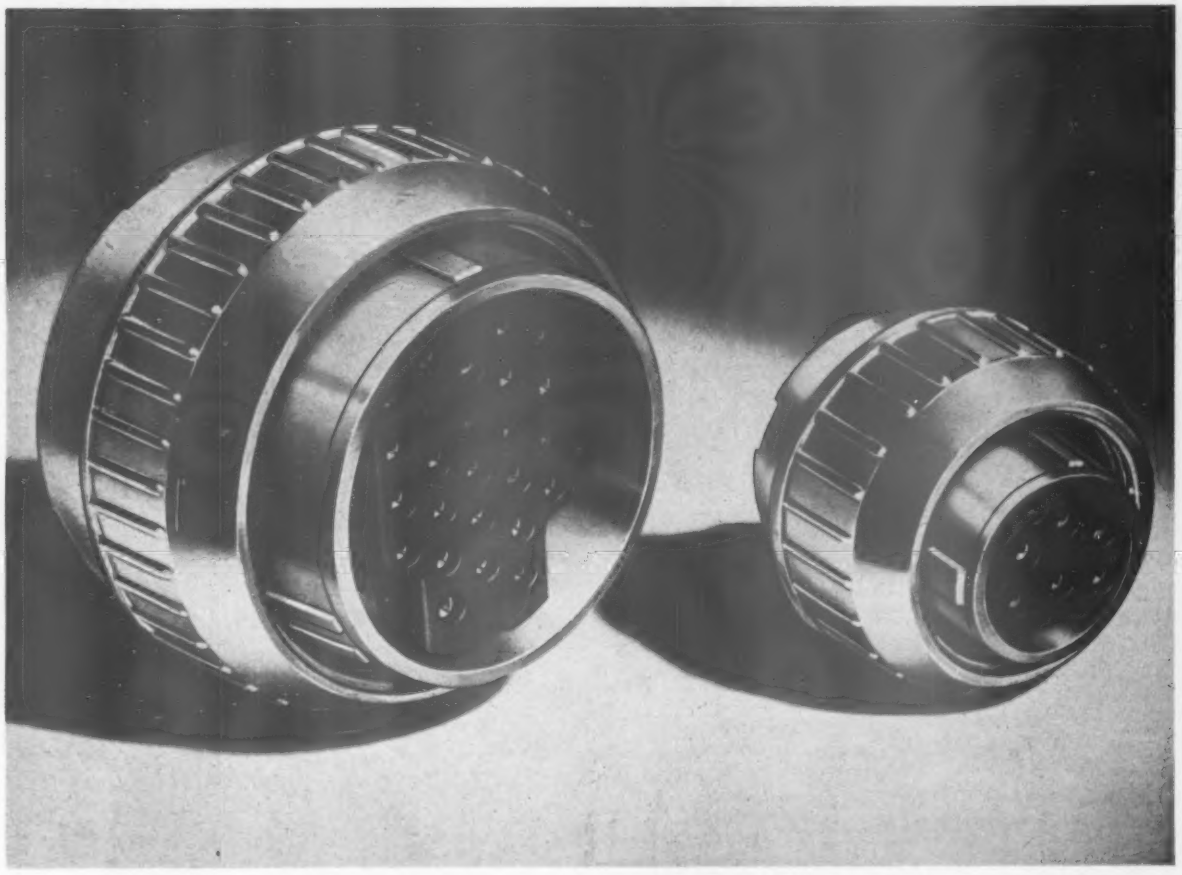

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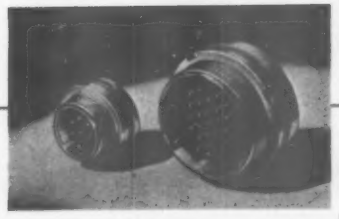

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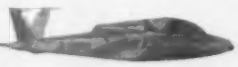

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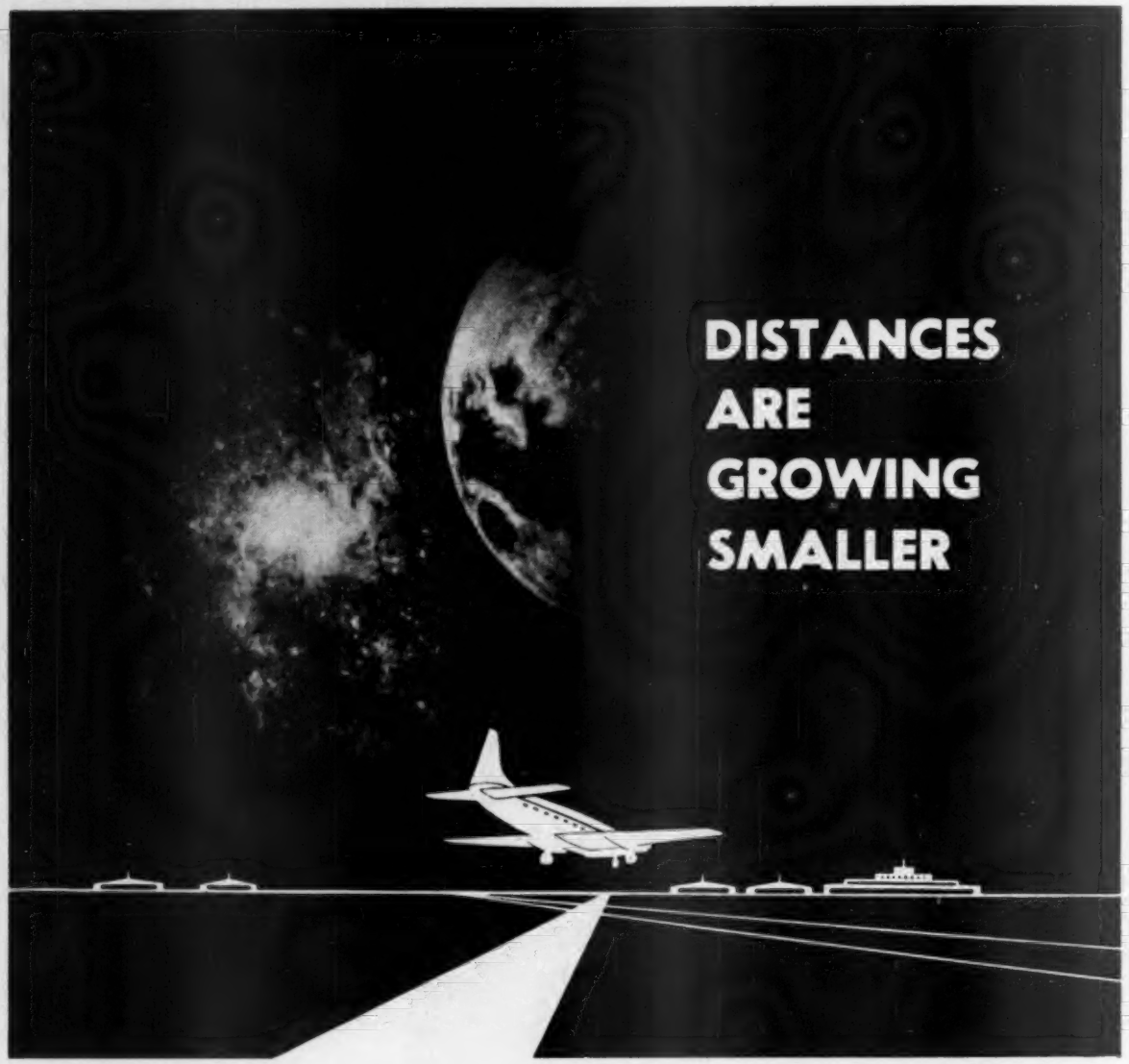

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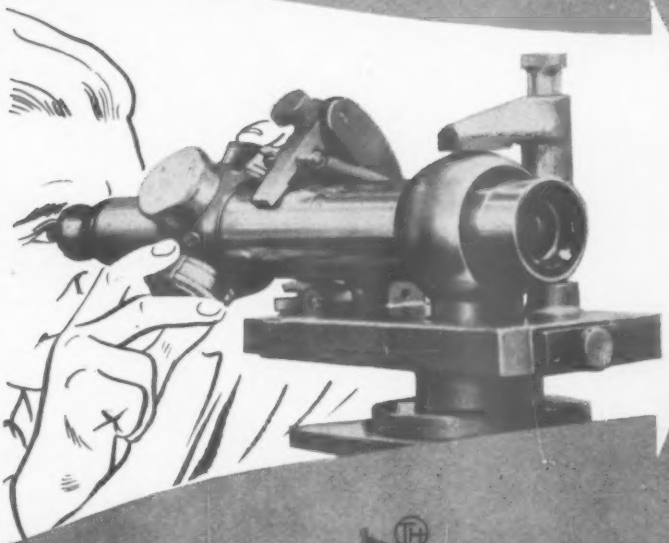

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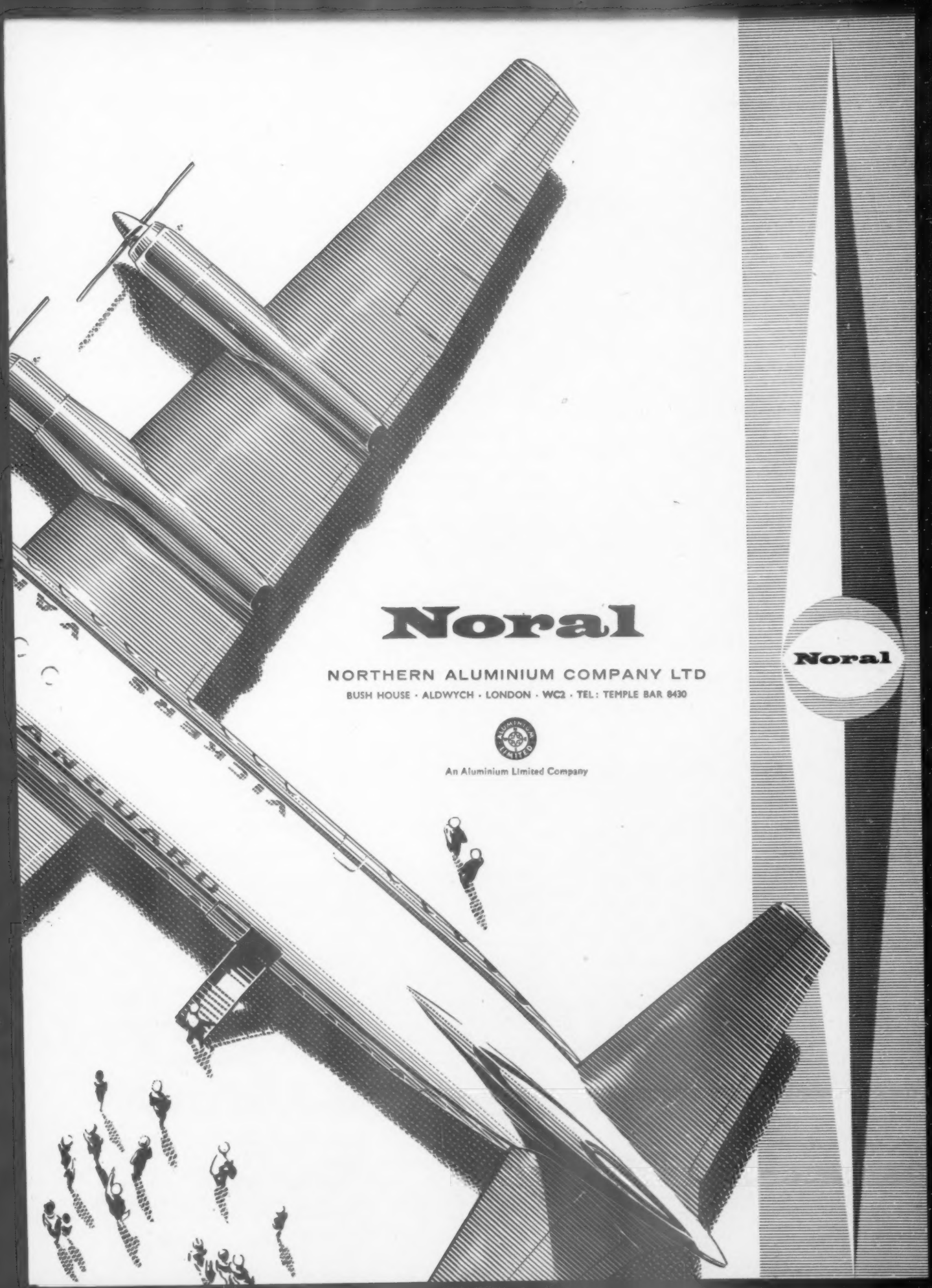
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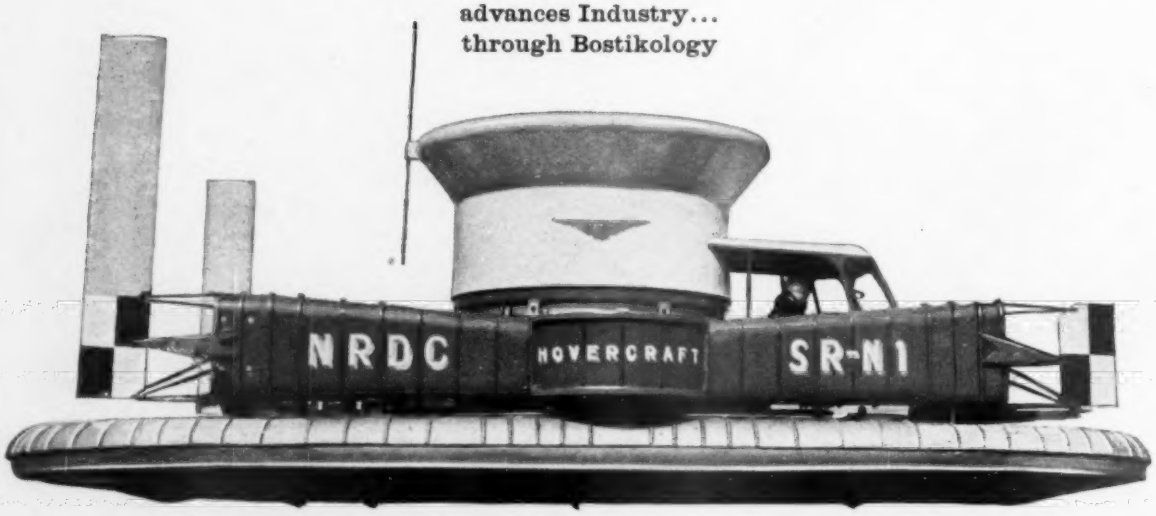

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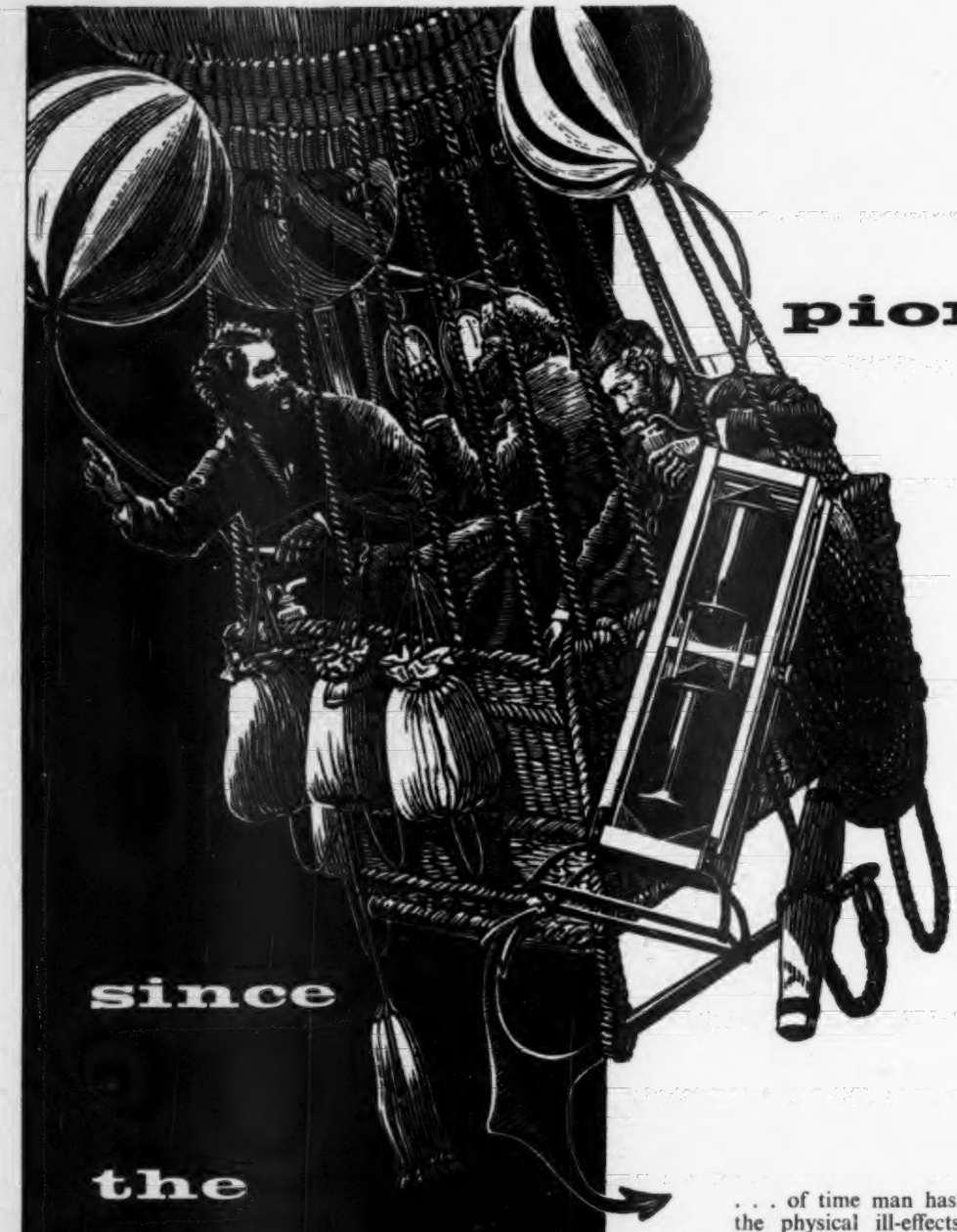

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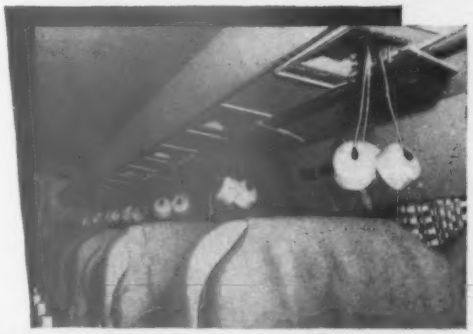

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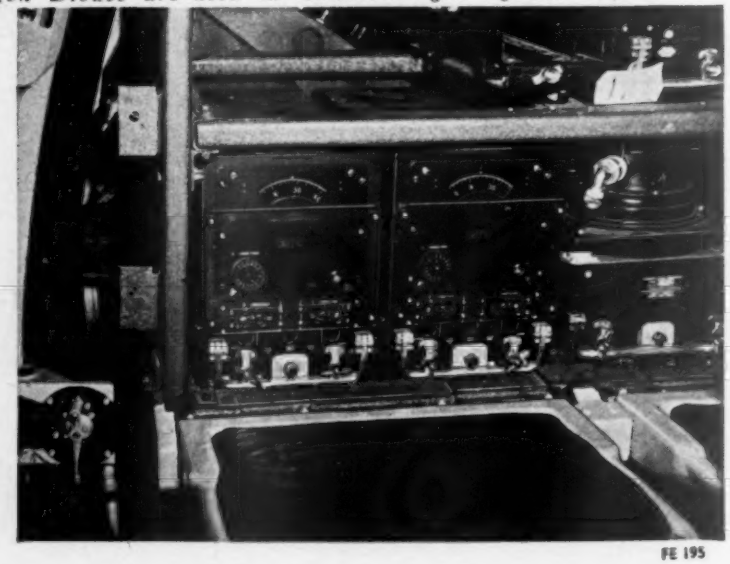

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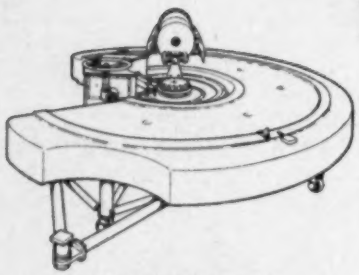

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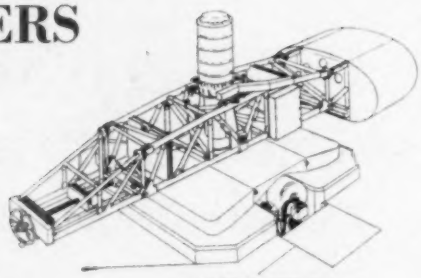

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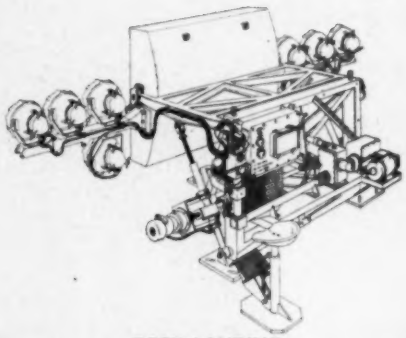

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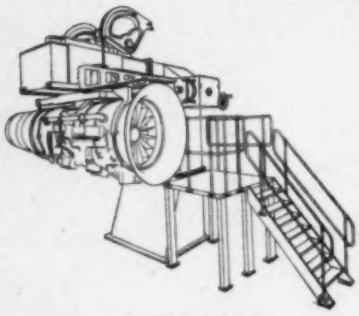

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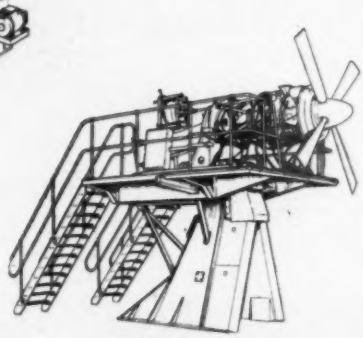

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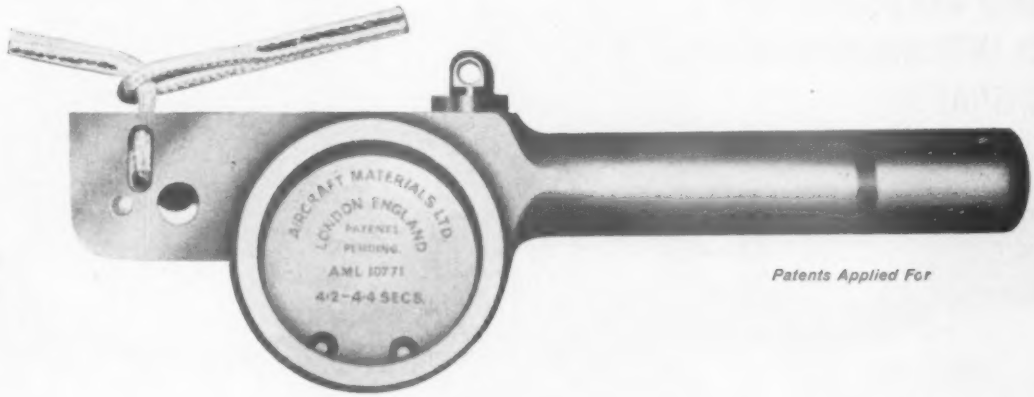

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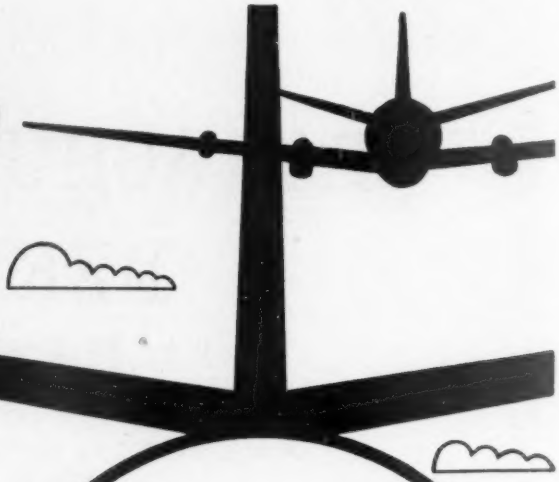

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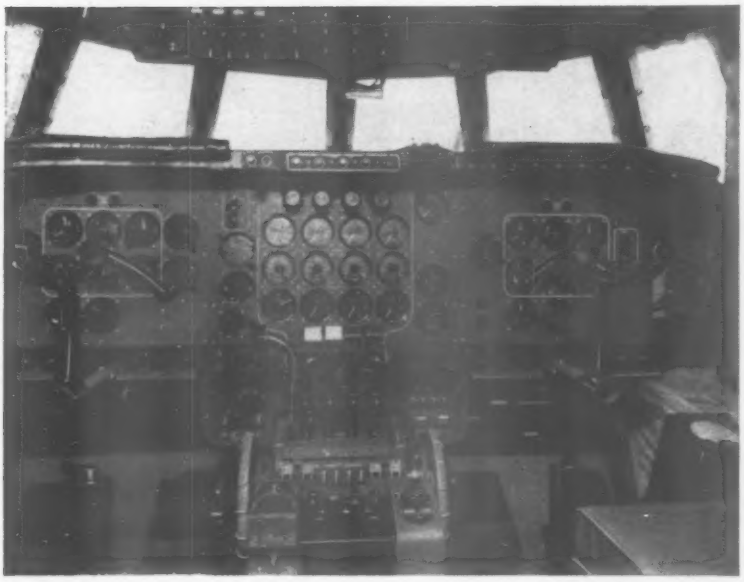

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THE AEROPLANE and ASTRONAUTICS

VOLUME 97 NUMBER 2498 SEPTEMBER 4, 1959

Biggest Yet

In this, the largest issue of our year, we set forth the products of the British Aircraft Industry with special reference to the forthcoming Exhibition and Flying Display at Farnborough. More exhibitors than ever before are taking advantage of the facilities which the experienced S.B.A.C. team, under the leadership of Mr. E. C. Bowyer and his No. 1, Mr. E. Goodinge, have built up over so many years. One has to be quite an old-timer now to recall the trestle tables in line on the grass airfield at Hendon following the R.A.F. Pageant with which it all began.

Exports have always formed an important sector of the Industry's business and figures are now available to show how impressively steady has been the growth of exports since 1946, rising from £14.7 million then to £154.1 million in 1958. The figures for the half-year to the end of June show that this year's total may be as much as £20 million better. The increasing importance of electronics is shown by the rise of this section to £3.3 million last year.

Such an impressive array of earnings in the foreign market should leave no one in the policy-making levels with any doubt of the importance of maintaining steady expenditure in research and development. The seeds sown in the laboratories and experimental departments ten years ago have grown into the present healthy harvest. In ten years' time the steady climb in earnings will only have persisted if advantage has been taken to back every promising development—and we must not forget that this means keeping up with developments in space exploration and travel.

Powerplants for Lighter Weights

A new class of aircraft is springing up for which it is difficult to find any suitable definition. The word "executive" has often been used but today business executives in the United States are being carried about their affairs in aeroplanes as large as Vickers Viscounts and to extend a classification from aircraft of this size to small twin-engined machines of high performance seems to be making a hard-working word work too hard.

In this country the new business is growing up as an extension of what used to be known as private flying, that is the operation of an aeroplane by an individual for business or pleasure. It began with sporting flying but today even the entries for sporting events spend much of their flying time on business flights.

From the original field of enthusiastic private owners the activity has spread to business organizations which have found that the aeroplane of limited size but high performance, if provided with the necessary radio and navigational aids, can be counted on as a speedy means of reliable transport independent of weather. And with a remarkable economy, for American four-seater aircraft in this category cruise at such high speeds that one may count on making good 120 m.p.h. ground speed on around six gallons of fuel, or at the rate of 20 ground miles to the gallon.

Business concerns in this country have already got beyond the utilization of small single-engined aircraft. Twin engines are now the

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order of the day and the number of seats is rising as the benefits of privately operated aircraft are increasingly appreciated.

This business is largely being handled at the present time by agents importing foreign-built aircraft. It has not been regarded as worth while by the British industry to design for this field; for one thing the market is too limited; for another, where are suitably cheap and efficient powerplants to come from?

In this field there has been no British activity for so long that the British aircraft constructor interested in using 250-h.p. piston engines has to go overseas. The vacuum formed by this absence of British-built piston engines of the flat-four and flat-six configuration has long remained unfilled but it is unlikely to remain so much longer. There seems no doubt that it will soon be worth while for a British engine manufacturer to acquire a licence. Indeed, this may have already taken place.

It was suggested some time ago by American sources that one of our largest engine manufacturers was interested in doing this, but no confirmation was forthcoming at the time. Now that a British aircraft constructor is to build a twin-engined freighter with such power plants, their manufacture in this country seems inevitable.

Matters of Moment

Farnborough Fare

ON Monday, September 7, the 20th Flying Display and Exhibition of the Society of British Aircraft Constructors opens at Farnborough. To mark the occasion in this issue of THE AEROPLANE AND ASTRONAUTICS, we have made a special feature of the things to be seen at Farnborough during the display (see page 101).

Although the accent both during the flying and in the static exhibition will primarily be on the faster and more powerful aircraft and on guided weapons, one must not overlook the products of makers of motorless aircraft. As we go to press we learn that, in addition to the main flying programme at Farnborough, this year for the first time there is also to be a gliding display at 12.00 hrs. on each of the three public days, September 11, 12 and 13. Five sailplanes will be flight demonstrated—an Olympia 403 and a 419, a Slingsby Eagle, a Slingsby Skylark 2 and a Skylark 3—and will be aero-towed by a Messenger and a Prentice.

Aerobatics and other manœuvres will be performed after release by the pilots, who will comprise David Ince and Flt. Lt. B. B. Sharman in the Olympias, Mrs. Ann Welch in the Eagle, Cdr. Nick Goodhart in the Skylark 3, and Derek Piggott in the Skylark 2.

The R.A.E.'s New Director

PROFESSOR MICHAEL JAMES LIGHTHILL, F.R.S., has been appointed Director of the Royal Aircraft Establishment, Farnborough, to succeed Sir George Gardner, K.B.E., C.B., D.Sc., F.R.Ae.S., who becomes Controller of Aircraft at the Ministry of Supply in October (THE AEROPLANE AND ASTRONAUTICS, August 28). Professor Lighthill has been Beyer Professor of Applied Mathematics at Manchester University since 1950.

Born in 1924, he was educated at Winchester College and Trinity College, Cambridge; he was elected F.R.S. at the age of 29. He is well known for his work in many fields of fluid dynamics as well as in pure and applied mathematics.

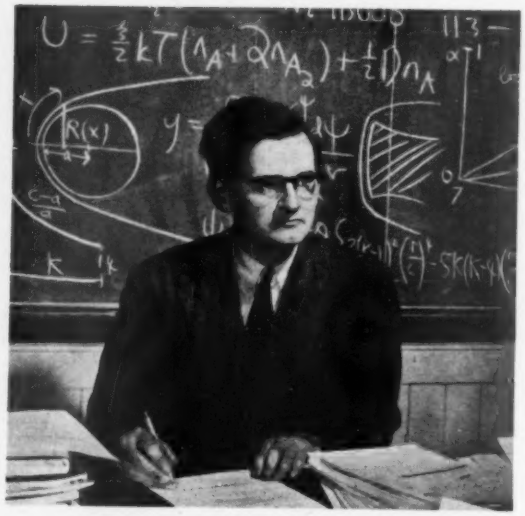
Professor Lighthill has made important applications of mathematics to aeronautical problems. His theoretical work on jet noise is particularly well known; this theory, which has been largely proved by experiment, relates the noise to the turbulence in the jet.

Executive Air Advice

NEWS of great importance to the future of business flying in this country was announced earlier this week. One of the most successful of the executive operators in this country—the aviation division of Sir Robert McAlpine and Sons, Ltd., civil engineers—is to make its 14 years' experience of business flying generally available through a new international advisory service.

McAlpine Aviation is offering advice on every aspect of executive operations to industrial companies and other businesses, ranging from the choice of one of two dozen or so suitable aircraft, with analyses of their operating costs, to the selection of pilots. It is also prepared to operate aircraft on behalf of interested companies, who would be offered an option to purchase them at a later date. Full maintenance and hangarage facilities exist at Luton for the care of company aircraft.

In the past four years, McAlpine Aviation has doubled its flying activities. Operating with a Gemini and a Rapide in 1955, it flew little more than 350 hours, but in the first half of this year, with a Piaggio P.166 and a Piper Apache, it flew a total of 285 hours. Equally significant as an indication of their short-range nature was the increase in the number of flights made, to a six-monthly figure of 594, 99% of which were within the U.K. area. The aircraft used are capable of operating from landing strips or any of the 200 or so recognized landing places in the U.K.



Prof. M. J. Lighthill, new Director of the R.A.E.

The Comet Improved

AN increase in the maximum take-off weight of the Comet 4 and 4C, from 158,000 lb. to 162,000 lb., has been announced by de Havilland. Future Comets of these two marks will have the same stub wing as the Comet 4B, making possible the higher gross weight without any increase in tare weight.

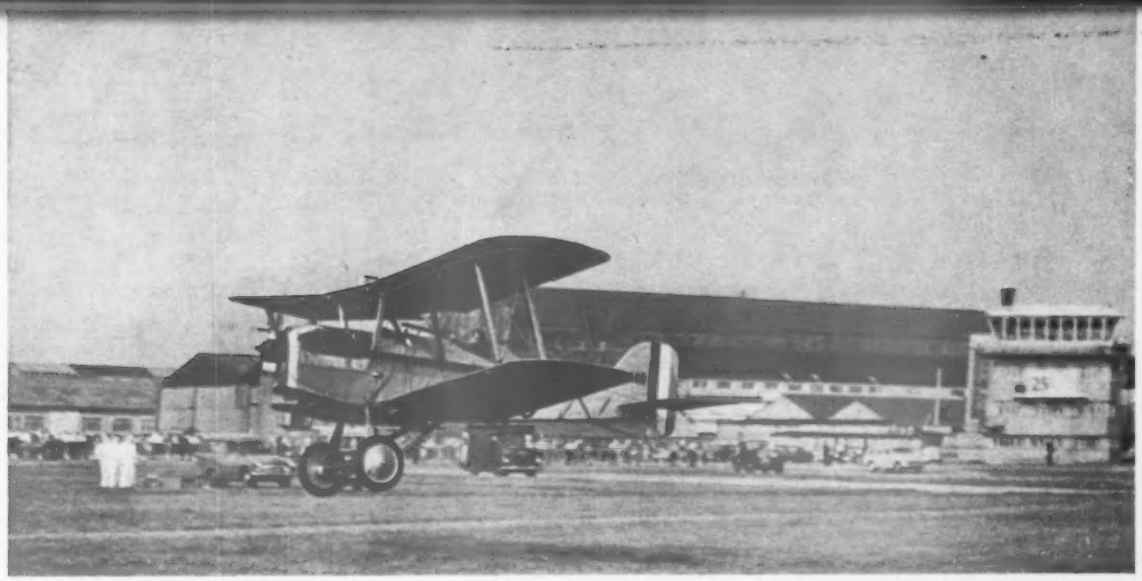
The extra weight permits the Comet to fly some 200 st. miles farther with maximum payload, or to carry some 2,700 lb. more payload over longer stages, when capacity payload cannot be carried. The range of the Comet 4 with capacity payload and full reserves will now be 3,225 st. miles, and of the Comet 4C, 2,820 st. miles.

H.P. on the Aircraft Industry

FIRM VIEWS on the aircraft industry's present condition have been expressed by Sir Frederick Handley Page in his annual chairman's review of the company's activities. Britain's aviation policy, he says, as yet shows little change.

Sir Frederick contrasts the lack of official support in this country for the development of the large and costly aircraft with which to take a share in the World's markets, with conditions elsewhere. "Our competitors in every country producing civil airliners for the World," he points out, "receive some form of government assistance. . . ."

"Certainly, the retention of Britain's virile private-enterprise aircraft industry is not solely a matter of prestige. The prosperity of our small group of islands is dependent on industry and efficient communications. Both will suffer if the life-blood of aircraft companies is squeezed from their veins. What an irrevocable loss it will be both to this country and to the British Commonwealth if we all become entirely dependent upon the design and construction (and whims) of our competitors."



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FARNBOROUGH'S FIGHTER.—A most successful fighter of the 1914-18 War was the R.A.E.-designed S.E.5a. Apprentices and enthusiasts at the Establishment have recently reconditioned one handed over to the Shuttleworth Trust by Sir W. G. Armstrong Whitworth Aircraft. On August 22, after speeches by Sir George Gardner and Air Cdre. Wheeler, it was flown by Cdr. K. Hickson, R.N. (in cockpit above) and by Air Cdre. Wheeler. The high compression geared French-built 200 h.p. Hispano-Suiza twelve-cylinder water-cooled engine was started by a genuine Hucks starter.

For the future, Sir Frederick considers that there are two needs to be satisfied—"the advanced sophisticated supersonic airliner and the fast economic coach of the air." The company's research programmes are aimed towards both these markets.

On the second of these projects, Sir Frederick says that research over the past years has shown that laminar-flow airliners will give hitherto unrealizable increases in range and load-carrying capacity, with corresponding reductions in operating cost and noise. Laminar-flow techniques are embodied in the H.P.113 project for a small jetliner for use as a long-range high-speed executive transport.

"This development of ours," says Sir Frederick, "is, in my opinion, as significant as such aeronautical milestones as the invention of the jet engine or of our renowned slotted wing of the 'twenties. Eventually it will bring aircraft economics down to a level at which the general public will think as little of spending holidays in, say, India or North Africa as they do now of going to Blackpool."

Speaking of financial matters, the chairman explains that the effect of delays in Victor production caused by changing operational requirements was still being felt in the period under review. This has the result that, for 1958, profit before taxation has fallen to £187,241.

This figure has been arrived at after writing off all expenditure incurred during the year on the design and development of Herald aircraft. The total written off to date amounts to £2,628,353. Recovery of the development expenditure written off, together with the production cost of £1,106,346, is dependent upon future Herald sales and to recover it all at least 80 aircraft must be sold.

Club's Successful Year

ONCE again the R.A.F. Reserves Club has had a most successful year. During the past twelve months negotiations were completed with the newly formed Battle of Britain Association, the Guinea Pig Club, and The Guild of Air Pilots and Air Navigators, which have resulted in their members becoming members of the Reserves Club. Additional support has also been given by the Airborne Club which shares the Reserves Club's facilities in South Street, Park Lane, London.

The social activities of the club have also been encouraging.

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MONTREAL TYNES.—The four Rolls-Royce Tyne RTy.12 engines of the first Canadair CL-44 freighter are now installed. This version of the two-spool Tyne delivers 5,730 e.h.p.

SCOTTISH SURVEYOR.—The Scottish Aviation Twin Pioneer modified for geophysical survey work, as described below.

An Exploratory Pioneer

AMONG the first customers for the Scottish Aviation Twin Pioneer was the Rio Tinto Finance and Exploration, Ltd. This company, with interests in South America, chose the Twin Pioneer as being the most suitable to undertake specialized geophysical surveys. The aircraft has now been extensively modified for this task, and will be exhibited at the S.B.A.C. Display next week before delivery.

Although this particular Twin Pioneer is readily convertible for a number of rôles, including freighting, executive transport and photographic survey, it is the equipment for geophysical survey which will attract most attention. This comprises an electro-magnetic unit, a magnetometer, a scintillometer, a strip camera and an Edin recorder.

The electro-magnetic unit, developed by the Mullard Research Laboratories, is designed to detect, from the air, zones of conducting material, such as massive metallic sulphides, at or below the earth's surface. It comprises a transmitter, a receiver and a display unit, and one of the problems, so far as airborne installation is concerned, is the need to locate tuned coils associated with the transmitter and receiver well apart from each other, and away from metals which might introduce false readings.

In the case of the Twin Pioneer, this has been achieved by mounting the units at either wing tip, in Fibreglass fairings. The wing tips have been extended, the new structure also being of Fibreglass, and the ailerons are fabric-covered with Fibreglass trailing edges. The coils can be orientated so that their axes are vertical or horizontal to the aircraft's line of flight.

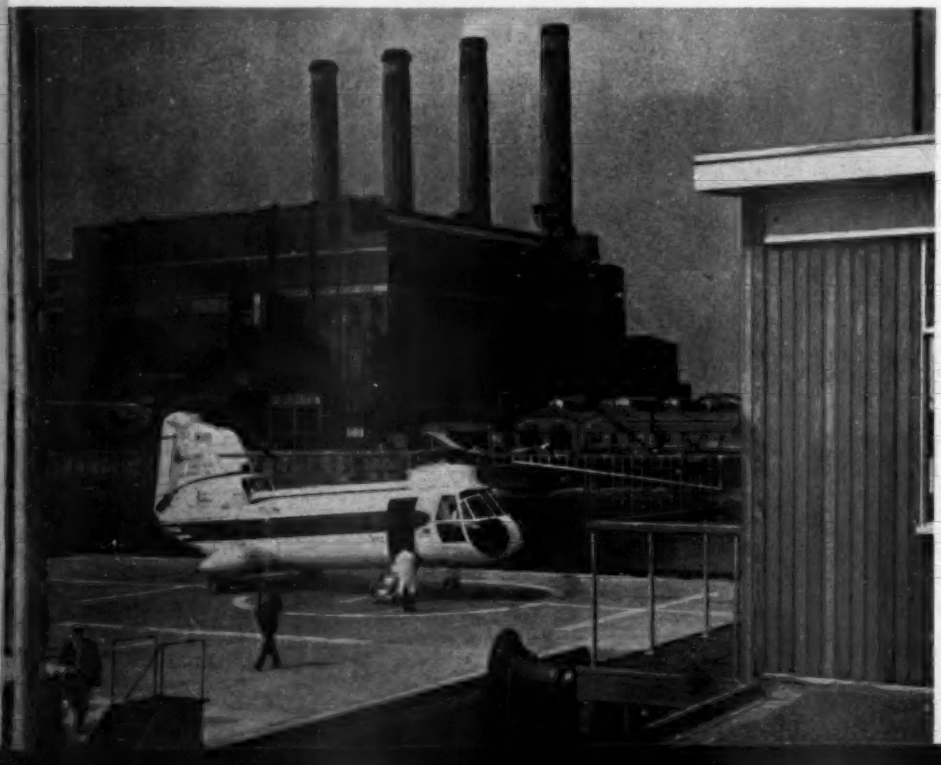
Of the other equipment the magnetometer is installed in the rear fuselage, and the scintillometer (to detect gamma radiation), the strip camera and Edin multi-channel recorder are in the cabin. The recorder is an eight-channel unit, providing for the electro-magnetometer in-phase and out-of-phase readings and an associated reading of atmospheric noise; the magnetometer reading; altitude from a G.E.C. radio altimeter; radio-activity from the scintillometer; turbulence from a wing strain gauge, and one spare channel.

The Twin Pioneer is operated by a crew of two and four surveyors. In the executive rôle, seven fully reclining seats replace the survey equipment. Other non-standard items are de-icing equipment, Standard STR 12D VHF radio, HAC.1 HF radio, Marconi AD 7092D ADF, Sperry AL3 gyro pilot, Kelvin Mk. 20 drift sight and a large hatch for cameras such as the Wild RL5 or RL7.

IATA and Lower Fares

SIR WILLIAM HILDRED, director-general of IATA, commented in London last month on the prospects of agreement on lower fares. He said that he hoped that the Association's traffic conferences this month will lead to a reduction of airline fares and the creation of second-class freight rates.

A lower economy-class fare, he said, would be both financially possible and necessary if the big turbojets are to pay their way. He hoped that a second-class cargo service, making use of fill-up space on passenger services, could be introduced experimentally for a period of a year. This lower-cost service might apply to those goods which could wait for a day or two until space was available. Such a service would encourage the use of the air by shippers of commodities which did not justify transport at present express air-cargo rates.



LONDON LINK.—This year a helicopter service will be available to take V.I.P. passengers directly to Farnborough and back from the Westland heliport at Battersea. A recent user of the heliport was this Vertol 107; an account of its visit appeared last week.

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Astronautics and Missile News

BLACK KNIGHT. — A two-stage version of the Black Knight re-entry research vehicle will be exhibited at Farnborough next week. Also shown will be an experimental nose section which re-entered the atmosphere at 12,000 ft./sec. from a height of more than 500 miles after a recent test-firing.

MALKARA ORDERED.—The Australian Malkara anti-tank missile has been adopted by the British Army. This missile has solid-fuel boost and sustainer motors; it is wire-guided and weighs about 200 lb.

STABILIZED NOSE-CONE. — On July 31, the U.S.A.F. published photographs of the Earth and Sun taken from the nose-cone of a Thor IRBM 316 miles above the Earth. The camera worked for eight minutes after the nose-cone and rocket afterbody had separated at a height of 85 miles. A capsule containing the camera was ejected before the nose-cone fell into the Atlantic. One of the photographs is believed to be the first to show both the sun and the curvature of the Earth in one picture.

CORVUS TESTED.—A test version of the U.S. Navy's new liquid-propellent rocket missile, the Temco Corvus ASM, has been successfully flown at the Pacific Missile Range Test Center, Point Mugu, California. The Corvus is an ASM for carrier-based aircraft and is designed to attack heavily-defended targets, including surface ships. Its initial air launching was from an A4D Skyhawk. It is powered by a Thiokol pre-packaged liquid rocket motor.

ORBITAL DISRUPTER. — The A.R.P.A. has awarded a $600,000 contract to the Radio Corporation of America for a study of the problem of intercepting and destroying a satellite in orbit. Contract is associated with Project Defender, concerned with the overall concept of "space defence."

NEXT WEEK

THE September 11 issue of THE AEROPLANE AND ASTRONAUTICS will be a specially enlarged one containing a first report from the S.B.A.C. Display at Farnborough. This will include a fully illustrated account of the flying display and preliminary details and photographs of the static show.

CAPSULE MISHAP.—An attempt to launch a full-size model of the Mercury space-capsule from a test rocket at Wallops Island, Virginia, failed on August 21 when the escape rockets on a pylon above the capsule went off prematurely about 20 minutes before launching time. The capsule, weighing about 2,000 lb., and containing instruments and radio equipment, was intended to have tested recovery devices. Instead the capsule left the rocket while still on the ground and fell into the sea.

General Aviation News

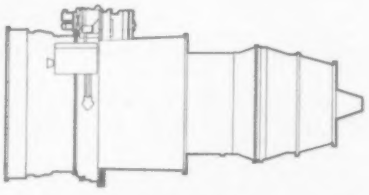
B-70 FUEL.—On August 10 the U.S.A.F. cancelled a £38 million programme to develop high-energy boron-based fuels for the Maeh-3 B-70 bomber, which will now use conventional jet fuels. The J93-5 exotic-fuel version of the General Electric engine for the bomber has also been cancelled.

707-320 PERFORMANCE.—The long-range Boeing 707 has improved on its guaranteed performance figures with "no-cost" increases of 11,000 lb. in its disposable load and of M=0.02 in its placard speed limit (now M=0.9). The increase in disposable load is the combined result of an empty weight which is 5,813 lb. less than the guaranteed maximum and an increase in maximum take-off weight to 302,000 lb.

VICTOR SEARCH.—A radome fragment from the Victor B.2 bomber lost during a test flight on August 20 was washed ashore at Whitesand Bay, Pembrokeshire, on August 25. According to the Ministry of Supply radar plots and eye-witness reports suggest that the disaster occurred suddenly about an hour after take-off and at very high altitude. Asdic searches and salvage operations by the Navy were due to begin on August 31.

ARGOSY TRIALS.—The second Armstrong Whitworth Argosy freighter-coach was scheduled to leave Elmdon on August 31 for tropical trials in the Sudan and East Africa. It was due to arrive at Khartoum on September 2, after night stops at Rome and Benghazi. After five weeks of trials in Khartoum it will fly to Nairobi for three more weeks of trials and is due back in Britain at the beginning of November. The trials team will be led by A.W.A.'s assistant chief test pilot, W. Else, accompanied by test pilots J. O. Lancaster and J. McCowan.

HELICOPTER PILOTS.—The first three Fleet Air Arm pilots to qualify under the new R.N. helicopter specialists scheme received their "wings" at R.N.A.S. Culdrose on August 28. The scheme provides a five-year commission for helicopter pilots.



BE.58.—This outline drawing shows the shape of the new Bristol Siddeley BE.58 ducted fan. Obviously a front-fan engine, the BE.58 has a thrust of about 17,000 lb., a high thrust-to-weight ratio, a low s.f.c. and a by-pass ratio approaching 2.

WORLD RECORD.—The F.A.I. has confirmed the World's closed-circuit speed record set up on February 25 by M. André Turcat. Flying a Nord 1500 Griffon (SNECMA Atar 101E turbojet) from Eyragues he achieved 1,643 km.p.h.

DC-8 DEMONSTRATION. — On August 26 a Douglas DC-8 was flown non-stop from Santa Monica to Jacksonville, Florida, and return (4,500 miles). The take-off weight was 270,000 lb.

INDIAN WIND-TUNNELS. — The Indian Council of Scientific and Industrial Research is expected to obtain French technical aid to set up its first transonic and supersonic aircraft wind-tunnels at Bangalore. Estimated to cost more than £11 million, the facility will be used to test Indian-built Gnats.

PRIZE ESSAY.—The chosen subject for this year's Cierva Memorial Prize Essay Competition is "Design Features and Uses of a Small Modern Autogyro." Closing date for entries is December 31, 1959, and the competition is open to entrants of any age or nationality. Details from the Helicopter Association of Great Britain, 4 The Sanctuary, Westminster, London, S.W.1.

MEMORIAL SERVICE.—A memorial service for Mr. Claude Grahame-White will be held at Christ Church, Down Street, London, W.1, at 12.00 hrs. on Wednesday, September 16.

ELECTRONICS LECTURES. — The Radar and Electronics Association's monthly lecture programme begins on October 27 at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2. All lectures will start at 7.30 p.m.

AIRBORNE CELEBRATION. — This year, Aviation Forum's annual dinner on Saturday, September 19, will take place in the air, over the English Channel and North Sea. It is believed to be the first time that an aeronautical association has held an airborne dinner. An Eagle Airways 100-seat, four-engined DC-6C has been chartered. The flight will last approximately 1½ hrs.; take-off, from Blackbushe Airport, will be at 19.00 hrs.

COMMONWEALTH CONFERENCE. —The sixth meeting of the Commonwealth Advisory Aeronautical Research Council is being held in London from today (September 4) to September 16 and follows visits this week to aircraft companies and the R.A.E. at Bedford. The chairman is Prof. W. J. Duncan, C.B.E., F.R.S., who is chairman of the U.K. Aeronautical Research Council.

ZAGREB VISITOR.—The Transland Ag-2 agricultural aircaft is to be displayed in the U.S. pavilion at the International Trade Fair at Zagreb from September 5-20. It is subsequently to be demonstrated in Europe, the Near East and North Africa.

Commercial Aviation Affairs

BRITANNIAS SOLD. — Two Bristol Britannia 305s have been sold to Transcontinental S.A., the independent Argentinian operator, for service between Buenos Aires and New York. Part of the fleet of five originally built for North-east Airlines, these Britannias will be delivered in October and November.

BACK TO ISRAEL.—B.O.A.C. is to resume services between Britain and Israel on November 1 after four years' absence from the route. Mixed-class Britannias will fly twice a week in each direction between London and Tel Aviv with an intermediate stop at Geneva.

S.A.S. AND THAI.—An agreement has been signed between S.A.S. and the Thai Airways Co. providing for technical assistance and the operation by S.A.S. of international services. A new company, Thai Airways International, is to be formed, with S.A.S. having a minority shareholding and providing aircraft crews and training facilities. Thai Airways have sold their three L-1049Gs to Aerovias Guest, of Mexico.

EXCHANGE NEWS.—The current issue of the Aircraft Exchange Market Report includes an offer to sell two Viscount 708As in the first quarter of next year, at $500,000 each. The Viscount 708 is the version operated by Air France.

THE U.K. SHARE.—In each of the years 1956, 1957 and 1958, the U.K. airlines' share of the World's passenger-mile traffic on scheduled service was 4.8%. A peak of 5% was reached in 1952 followed by a decline to 4.6% in 1954. The U.K. share of international traffic declined from 14.6% in 1953 to 13.8% in 1957 and about 12% in 1958.

KABUL REBUILDING.—Within 18 months, Kabul Airport is to be rebuilt, with a main 9,850-ft. runway. The work will be undertaken by the Soviet Techno-Export Agency, but meteorological and communications equipment has been ordered from the U.S.A.

K.L.M. STYLING.—The Royal Dutch Airline is the latest to plan a new colour scheme for its fleet. Illustrated on a Lockheed Electra in our issue for August 21 (p. 43), the new livery includes a two-tone blue striped fin and rudder and the wording "K.L.M. Royal Dutch Airlines" on each side of the fuselage in place of the former "Flying Dutchman" sign.

SANTA CRUZ EXTENDS.—The main runway at Santa Cruz airport, Bombay, is being extended to 10,500 ft., and the four hills, known as the Kurlas, on the approach are being removed.

IATA ASSOCIATE.—South West Airways (Pty.), Ltd., a domestic operator in South-West Africa, has been admitted to IATA as an associate member.

STRAWS IN THE WIND?—One of the Airwork fleet of Vikings has been re-registered in the name of United Airways Ltd.—a company formed by Airwork some years ago but not at present operating. The fleet of Bristol 170s used by Air Charter Ltd.—another company in the Airwork group—for vehicle ferry services now operate under the name of Channel Air Bridge.

JUMPER.—The two-seat, 180 h.p. Umbaugh-18 jump-start gyroplane is to be manufactured by Fairchild Engine and Airplane Corp. It is expected to sell for about $10,000 and, if flown for 300 hr. a year, will cost six cents a mile to run, including maintainance costs.

News About People

THE AIR COUNCIL.—Air Marshal Sir Arthur McDonald, K.C.B., A.F.C., at present A.O.C.-in-C., Technical Training Command, has been appointed Air Member for Personnel with effect from October 1. Air Vice-Marshal S. C. Elworthy, C.B.E., D.S.O., D.F.C., A.F.C., Commandant of the R.A.F. Staff College, is to become Deputy Chief of the Air Staff on November 15, with the acting rank of Air Marshal.

GOING TO SHOREHAM.—Mr. R. E. Bird, M.I.A.S., A.R.Ae.S., has joined F. G. Miles, Ltd., as manager of the company's Special Project Design Division. Since 1947 Mr. Bird has been chief designer of Auster Aircraft, Ltd., of which company he has been on the board since 1957.

Mr. K. Fearnside

Mr. R. E. Bird

ON THE SMITHS BOARD.—Mr. K. Fearnside, A.M.I.E.E., A.F.R.Ae.S., has been appointed to the board as director of research, Smiths Aircraft Instruments, Ltd. He has been with the Smiths Aviation Division since 1953 and for the past two years has been research manager at the company's Cheltenham factory. He will continue to have charge of research activities in his new appointment.

SAUNDERS-ROE SECRETARY.—Mr. N. H. P. Taylor, F.A.C.C.A., has been appointed secretary of Saunders-Roe, Ltd. He joined the company in 1940 and has been deputy secretary and chief accountant for some years; he retains the latter appointment.

R.A.F. BENEVOLENT FUND.—The Dowager Viscountess Trenchard has been appointed a vice-president of the R.A.F. Benevolent Fund, which was founded by Lord Trenchard in 1919.

CHAMPION GLIDERS.—Britain's team taking part in the 1960 World Gliding Championships in Germany is to be chosen from the following six pilots: Lt.-Col. A. J. Deane-Drummond; Cdr. H. C. N. Goodhart; Lieut.-Cdr. G. A. J. Goodhart; D. H. G. Ince; G. H. Stephenson; Sgt. J. S. Williamson.

MICROCELL EXECUTIVE. — Air Chief Marshal Sir John Baker, G.B.E., K.C.B., M.C., D.F.C., R.A.F. (Retd.) has joined the board of Microcell, Ltd., as an executive director. Sir John was controller of Aircraft at the Ministry of Supply from 1953-1956, before he retired from the Royal Air Force after a long and distinguished Service career.

K.L.M. APPOINTMENT. — Mr. Leonard Koops has been appointed manager of K.L.M.'s U.K. and Ireland stations. His predecessor, Mr. Albert Janssen, is to become K.L.M.'s manager in New Guinea.

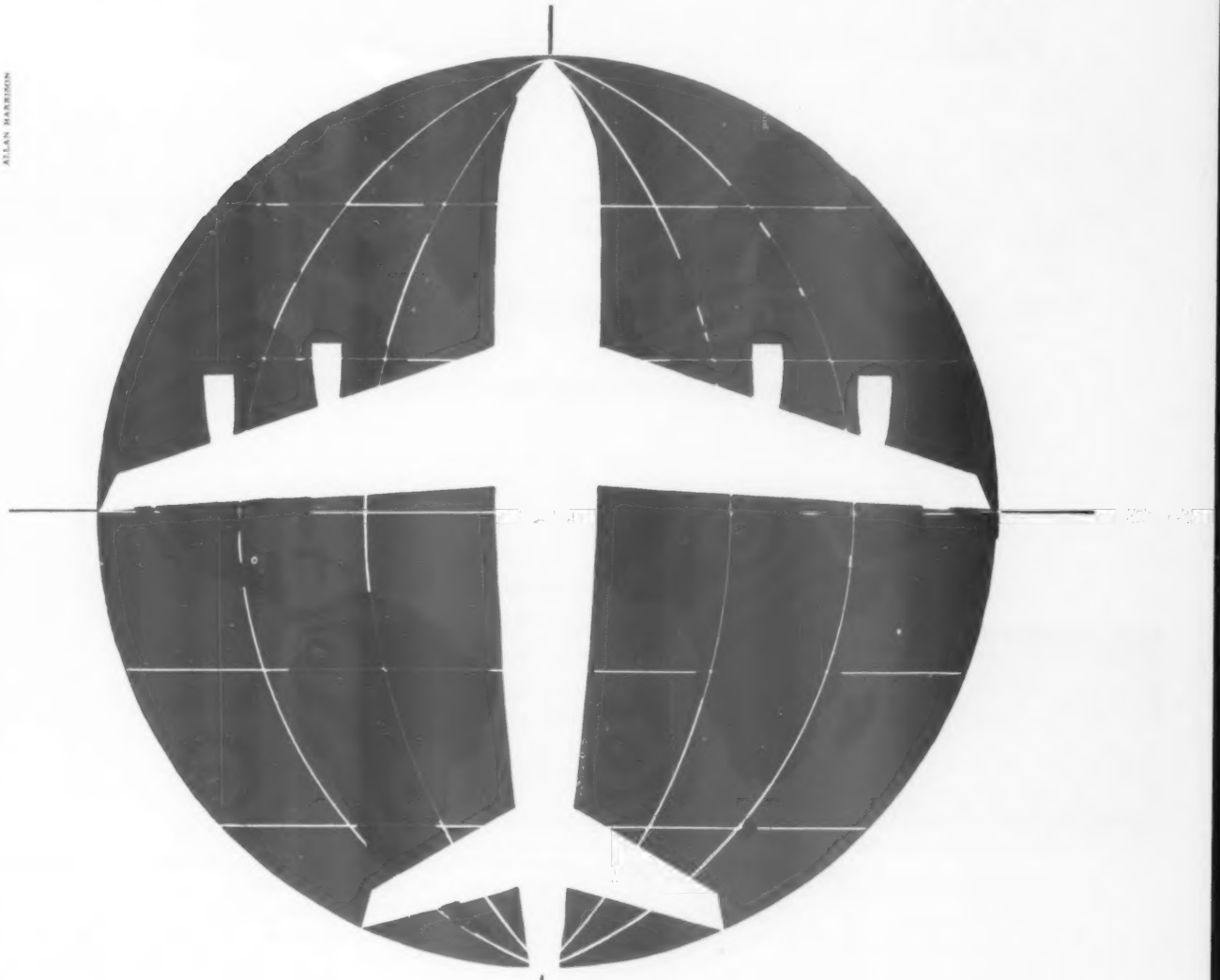
MOND AND WIGGIN CHANGES.—Mr. L. H. Cooper has relinquished his positions as chairman and director of Mond Nickel Co. and Henry Wiggin and Co. He is succeeded as chairman of these companies by Mr. G. Archer.

Mr. I. A. Bailey, Dr. L. B. Pfeil and Mr. J. O. Hitchcock are appointed managing directors of Mond Nickel with responsibilities, respectively, for operations, research and technical, and commercial. Mr. Bailey continues as managing director of Wiggin, of which company Dr. Pfeil and Mr. Hitchcock are directors.

Dr. A. G. Ramsay becomes a director of Wiggin and continues as the director of Mond resident at Clydach, Swansea. Mr. F. Dickinson becomes a director of Mond and continues as manager of the development and research department of the company.

MR. A. H. LANGFORD. — Mr. Archibald H. Langford, director and general manager of Heenan and Froude, Ltd., died in Worcester Royal Infirmary on July 19, aged 64. He began his career with Heenan and Froude, Ltd., in 1911, becoming works manager in 1928. In 1944 he became general manager and, in 1946, a director of the company.

ALLAN HARRISON



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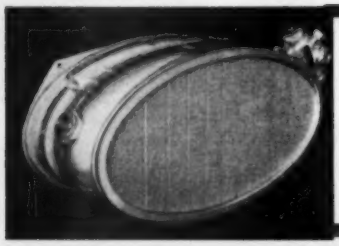
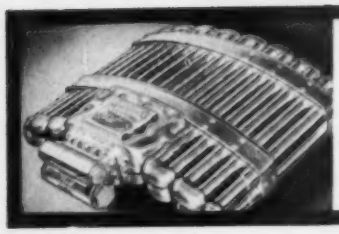
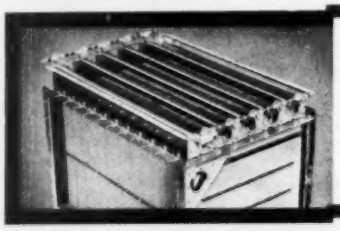


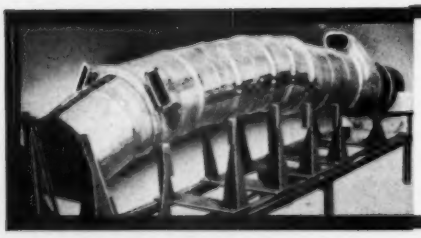
Oil Coolers in light alloy. They are light, compact, and can be designed to fit almost any space, no matter how awkward.



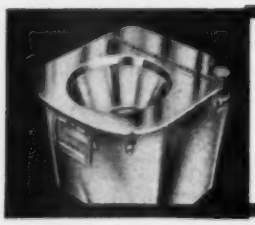
Fuel-cooled Oil Cooler for gas turbine and turbo-prop engines. By using fuel as the coolant, these units cool the oil and warm the fuel at the same time, an obvious advantage when using kerosine at high altitudes.



Anti-Icing Heat Exchangers. Our system uses hot gas from the exhaust or engine compressor to heat air which is then piped to the aerofoils. It prevents ice from forming, is non-electric and has no moving parts other than an on-off control.



Thermal Insulation Blankets. Constructed from the insulant Thermoflex R.F.300 sandwiched between dimpled ·004-in. stainless steel. Welded channel edges are completely sealed against the ingress of fuel. Average weight :—0·65 lb. per sq. ft. We 'make to measure' to suit any installation. No problem of size or shape is too difficult.



Stainless Steel Toilets. Self-contained *flushing* toilets requiring no ground equipment, extra tanks or bulkhead stressing. They obviate fuselage corrosion and are interchangeable with existing units.

Delaney Gallay Toilet Fluid. A new formula that definitely kills odours and sterilizes. It is not affected by high altitudes or temperatures.

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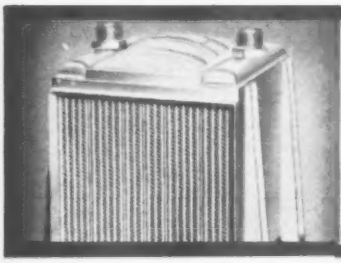
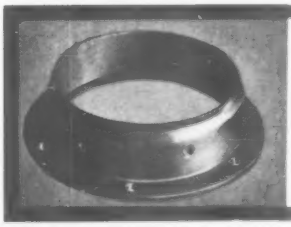
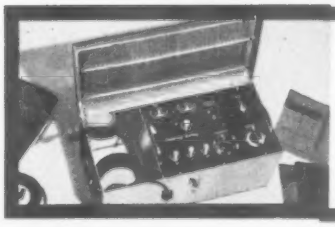


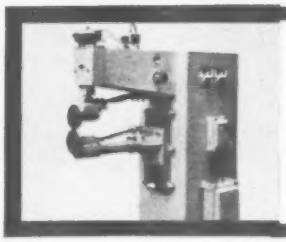
Flux Bath Brazing. A process for light alloy brazing that permits inaccessible joints to be made, without intolerable distortion, in metal as thin as ·006 in. It is a simple fact that units can be made in the flux bath so small and so light that it would be impossible to make them by any other method. We shall be exhibiting examples of such work.



Stainless Steel Fabrication. We have developed techniques that often enable us to make direct from strip items that would normally have to be drawn or forged. We can often, therefore, obviate the necessity for lengthy and costly tooling processes, and can work equally well in any gauge from ·002 in. to $\frac{1}{8}$ in.



The 'Incorporall' Portable Welding Kit. A completely self-contained Kit for welding mild and stainless steels up to 22G. The electrode can be used either in a hand gun or as a foot-operated pencil unit. The 'Incorporall' is suitable for all climates and is complete with tools and operating data.



Universal Welder. With attachments, this machine is equally suitable for seam, spot or projection welding. Its bottom electrode carrier is mounted on a curved seating that can be tilted so that alignment is always perfect. We shall also have other machines on show, including a seam welder that can operate when only one side of the job is accessible.

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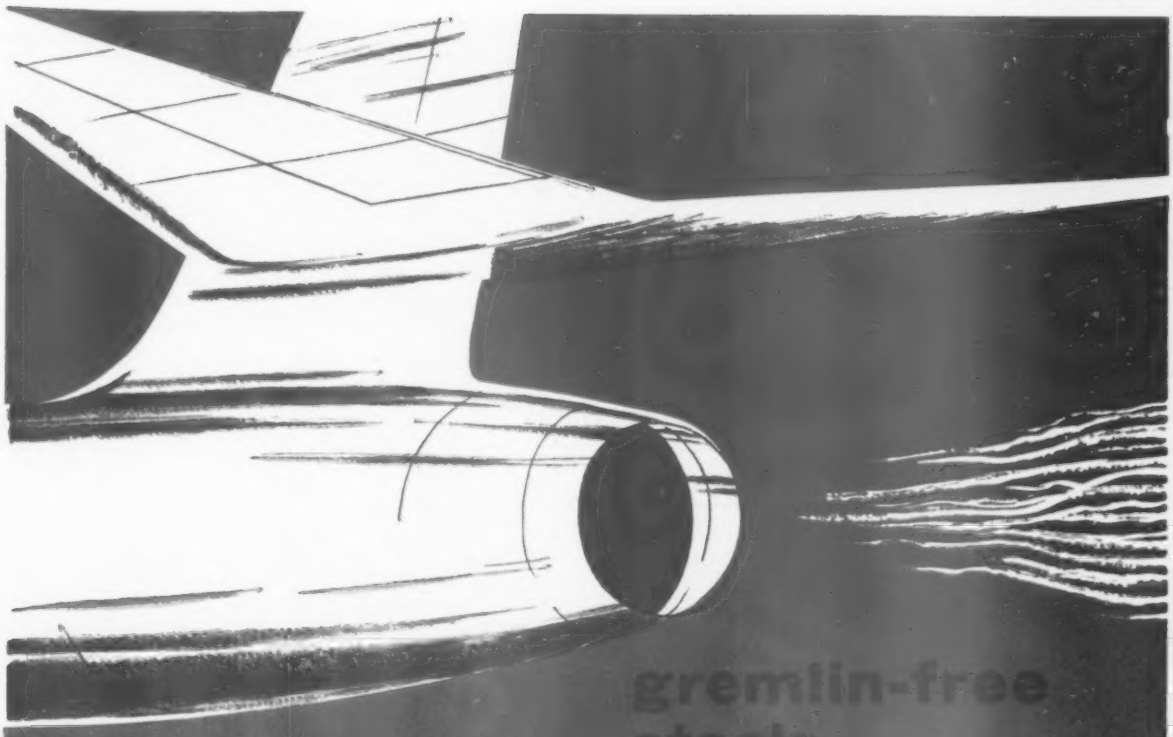

gremlin-free steels

Melting metals in vacuo—
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The best of air-melted steels are not free from non-metallic inclusions.

VACUMELT for components that must not fail

Vacuum melting permits closer control of chemical composition, and gas content, and gives greater freedom from impurities. It gives "Vacumelt" steels improved ductility — on a 12% chromium steel sample, transverse ductility was *four times greater* than that of a similar air-melted steel — and higher resistance to fatigue and creep. For highly stressed steel components that must not fail, "Vacumelt" is essential.

Hylite

Jessop-Saville have also developed the "Hylite" Titanium alloys to meet the design requirements of high-speed aircraft and missiles. They are available in 7 different grades with U.T.S. values ranging from 27 to 80 tons/sq. in.

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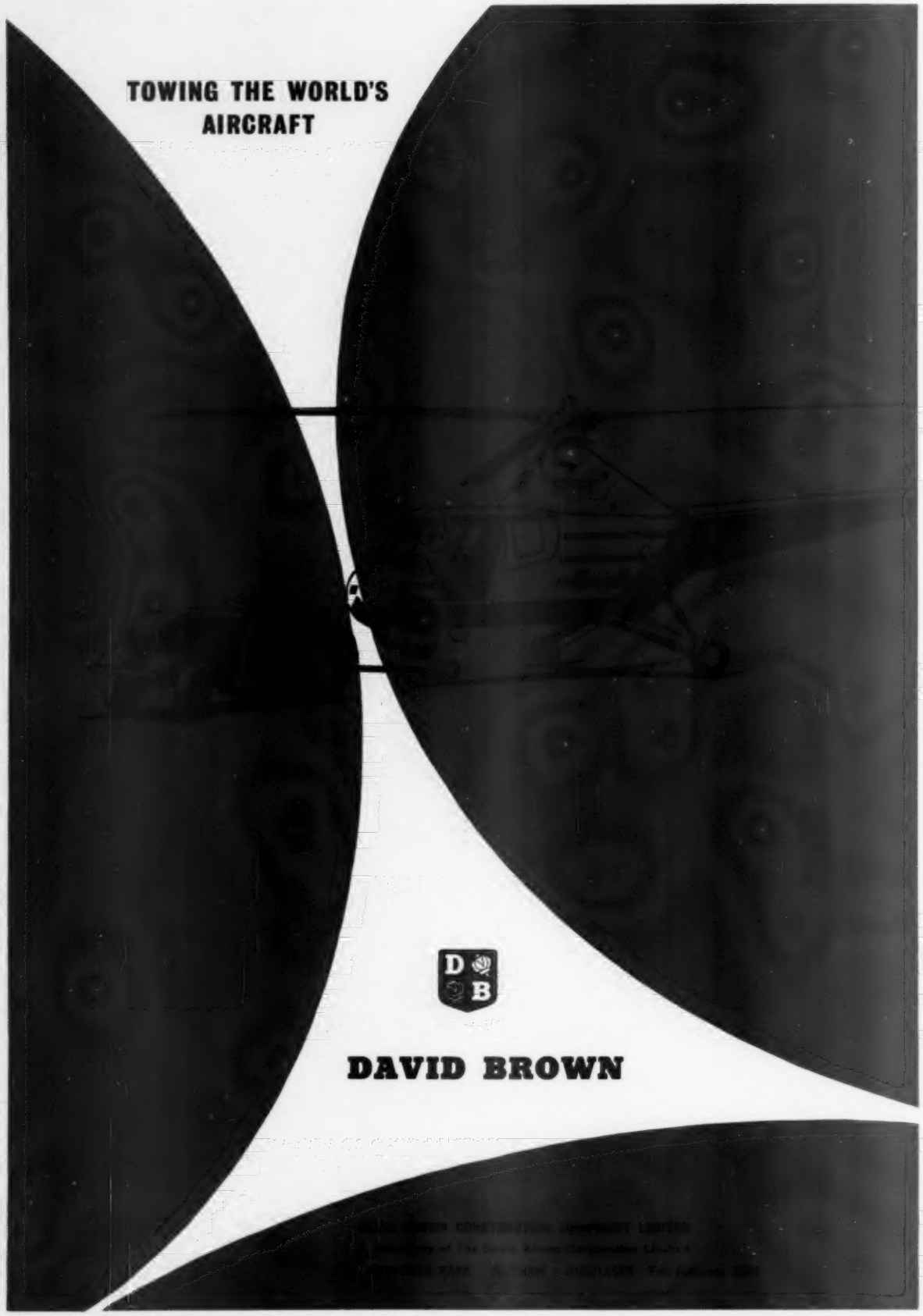
P3415

TOWING THE WORLD'S
AIRCRAFT



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TODAY'S PRODUCTION PAVES THE WAY FOR THE AIRCRAFT OF TOMORROW

This illustration shows a scale model of a projected supersonic airliner exhibited on the Lockheed Stand No. 45 at S.B.A.C. exhibition.

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Air Transport

B.E.A.'s Report in Retrospect

IN last week's issue (p. 49) the essential features of B.E.A.'s 1958-59 results were summarized. Despite adverse factors a useful profit was returned for the fifth year in succession. These factors, explained in the report, were: the European sub-depression; the familiar peak-trough problems; domestic service losses; and the depredations of the independent operators. Some of the major policy views outlined in the published report can now be discussed.

The most important of the policy statements are those made about the Corporation's attitude towards fare reductions. These statements are less positive than had been expected and are somewhat confused by references to the lessons learned from the vigorous exploitation by the independent operators of the market for inclusive tours.

"We had hoped," the report says, "that it would be possible to go over completely to this new [economy fare] policy throughout Europe in 1960. There are, however, clear indications that practical difficulties faced by other airlines . . . will make difficult the full implementation of this policy in 1960." So B.E.A. will presumably go to the IATA traffic conferences this month with a programme for differential and promotional fares which are likely to be accepted—rather than with an overall lower fare policy which would not have been entirely successful, but which would have demonstrated a positive intention.

Yet the report remarks that the continued expansion of packaged tour traffic and the success of the economy fares on the North Atlantic "confirmed our view that European air fares must be brought down" and that "in a year in which money was in short supply there was still a rapidly expanding market for the cheapest kinds of air travel." In other words, lower fares encourage traffic and the public has now learned that such fares are possible.

Several references are made in the report to the inroads made by the independent operators into the traffic which might otherwise have gone to B.E.A. Obviously, the Corporation must fight for all the traffic it can get and nobody can blame it for getting into the inclusive tour or any other profitable business. But the basic issues involved do not seem, to the outsider, to have been very adequately explained.

It is very galling for B.E.A. to find that its traffic to Nice dropped by 15% during the 1958 summer (with Air France suffering a similar reduction) when that carried by the independents on charter and I.T. services increased by 49%. But it would be even more galling for the general public to find that they had to travel by scheduled services and at present scheduled rates or not at all. B.E.A. now has IATA approval to carry I.T. passengers on a number of scheduled services at rates up to 25% less than the normal fares—but, since 1952, the Corporation has, at least theoretically, been just as free as the independents to apply for approval to operate exclusively I.T. services.

In its report B.E.A. suggests that there is a "serious weakness" in the system by which charters by "closed groups" can be operated without approval from the A.T.A.C.—adding that almost as many passengers travelled to Europe on services of this kind in the summer of 1958 as on inclusive tour services duly authorized by the Council. The removal of this freedom might be as helpful to the Corporation as it would be damaging to the independents—but the real point is that such a restriction would deny the already very limited right of the general public to choose their own method of travel and to negotiate their own rates. This freedom, already little more than vestigial, must not be allowed to disappear altogether.

Incidental information in the report included the fact that aircraft utilizations were high, with the average for the Viscount 701s running at 2,468 hr.—the highest ever achieved by B.E.A. with any aircraft type. During its first year of service the 806 averaged 2,080 hr. Such figures are not easily obtained by an airline whose average flight time is only 1½ hr. The Rolls-Royce Dart 506 and 510 inter-overhaul periods, at 2,300 and 2,200 hr. respectively, are probably the highest approved for any engine in the World.

The Comet 4Bs may be in service in October or November on the Athens route; full-scale operations, including those to and from Moscow, will start in 1960. The Vanguard will be in service during the summer of 1960. A more intensive use of Gatwick can be expected in 1961.

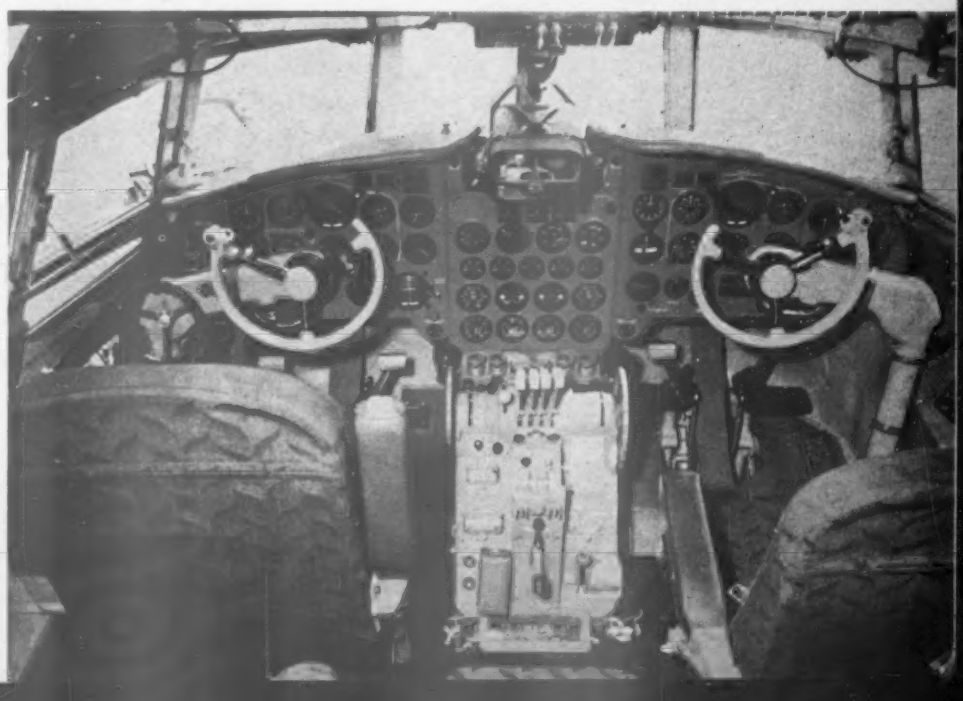
The New FIDO

A LITTLE more information recently became available about the prospects of FIDO. Work on a modified system started, at R.A.F. Marham, in the spring of 1957 and the installation was completed in the summer of 1958. Trial burns showed up a technical fault (believed to be concerned with flow restriction in the system); the remedies applied since then have not cured the trouble and modifications are now being made.

Assuming the technical success of the new system and that an annual average of 1,000 take-offs and 1,000 landings were made with its use, the estimated cost to the operator (presumably including interest on the cost, approximately £500,000, of the installation) would be in the region of £150 per take-off and £300 per landing. These figures are probably higher than any which would be accepted by the operators.

In due course, when tests have been completed successfully, the prospects of the system and its value to operators will be reconsidered in relation to the development of the B.L.E.U. automatic landing system and its use by future aircraft.

The questions involved are not simple. Whether FIDO could be used on a regular basis would depend on the application of new, FIDO-provided, minima, acceptable to insurance interests, pilots and the travelling public. The fact that a landing could be made in certain conditions does not mean that it would be made; a diversion might, on many occasions, be preferred for economic as well as for safety reasons. The old FIDO system was available for emergency use for some time both at Manston and Blackbushe, but was used on only one occasion—for a take-off at Blackbushe with urgently needed bullion.



RUSSIAN FLIGHT DECK.—The Ilyushin Il-18 turboprop transport at the Paris Exhibition was styled to Western ideas. This photograph shows the way in which the light-grey colour for the dashboards, and the use of light colouring generally, gives the control cabin a pleasantly airy appearance.

Photograph copyright "The Aeroplane and Astronautics"

Air Transport . . . .

Prospects for the Avro 748

BY the end of next year, production models of the Avro 748 twin-Dart feeder-liner are expected to be in the hands of Skyways, the British independent operator, for route proving and intensive flying trials. At least two production aircraft will be used in this way in the 1,000-hr. flight development programme for a full British C. of A. by the middle of 1961.

Before production deliveries begin, four prototypes will be built at A. V. Roe's Chadderton, Manchester, factory. The first of these four is now rapidly taking shape, as the photographs show, and is expected to fly from Woodford airfield before the end of next February. The second is a structural test airframe; the third is another flying prototype, scheduled for completion in August, 1960; and the fourth is the fatigue test specimen for water-tank testing.

Two more sets of assembly jigs are now being put down, and production of an initial batch of 10 aircraft and parts for 10 more is proceeding. Depending on orders, up to 20 production 748s could be delivered in 1961. The first metal was cut for the prototype only in February of this year, a month or so after the company decided to go ahead with the project as a £2¼ millon private venture. Before this decision was reached, a survey was conducted, principally among airlines in Europe and South America, to discover their reactions to the proposal.

This survey showed that there was a good chance of the Avro 748 being successful, and Skyways, Ltd., became closely associated with its development. This company has given a letter of intent for three aircraft and the British Government has also indicated its willingness to purchase three to be used—probably—by a B.O.A.C. associated company. Although precise details of the recent agreement between Hawker Siddeley and the Indian Government have still to be worked out, it is likely that this will call for delivery of a batch of 748s from Britain, followed by sets of parts for erection at a new factory to be built at Cawnpore, where the whole aeroplane will eventually be fabricated. The agreement at the moment concerns only the Indian Air Force, but there is little doubt that the Indian Airlines Corporation will also buy the 748.

In the year or so since the Avro 748 project was first offered to the airlines, many have shown positive interest, and a large number of detailed route analyses have been completed by Avro. Eventually, sales in the Asian area may be handled by the Indian production line. An impression of the Avro 748's structural features will be found on page 115 of this issue together with a brief specification. More details of the design, construction and performance—both with Dart R.Da.6s and the larger R.Da.7s—will be given next week.

AVRO PROGRESS.—These pictures, taken last week, show (top) the fuselage and wings of the Avro 748 prototype in the jigs at Manchester. Bottom left is a view inside the first fuselage and bottom right, the engineering mock-up.

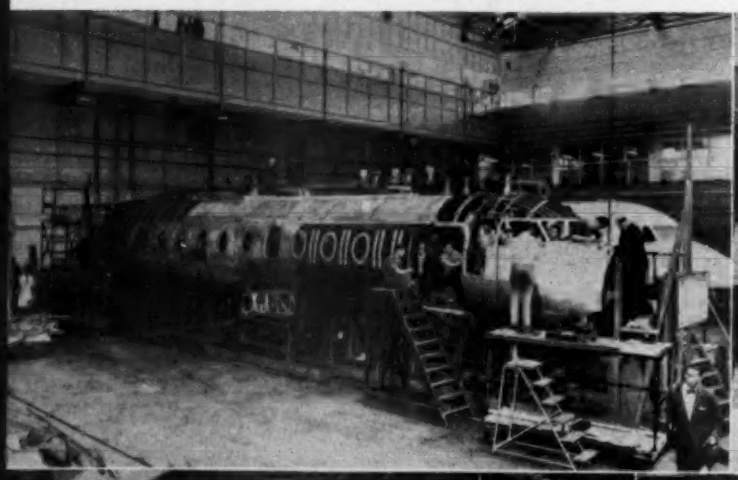
The Corporations Scrutinized

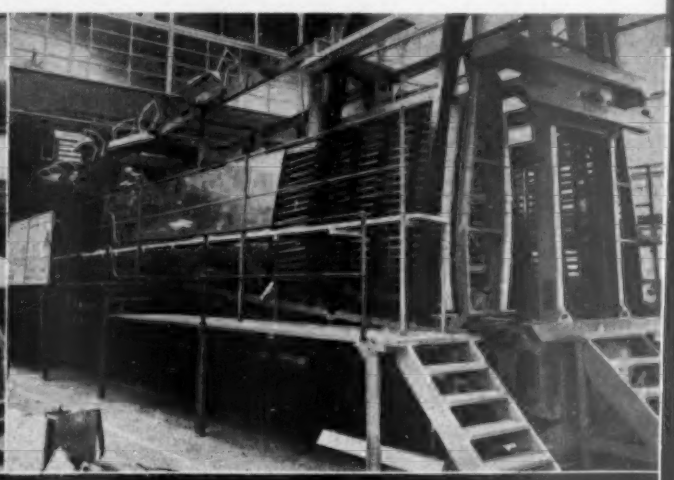
BOTH B.O.A.C. and B.E.A. come in for a measure of criticism in the report of the Select Committee which has been investigating the reports and accounts of the two British air Corporations.* Since it was hardly likely that so thorough an inquiry would fail to indicate some unsatisfactory aspects, the Corporations can feel satisfied—and B.E.A. more especially—that, on the whole, the report is favourable, and even complimentary.

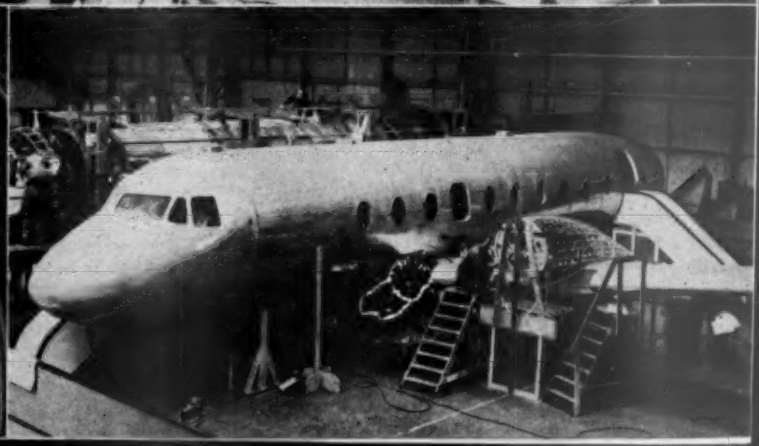
The criticisms, so far as B.O.A.C. is concerned, deal largely with the high level of engineering costs, which lie at the heart of their indifferent financial results in the past few years. This problem was recognized within the Corporation by 1952 and was investigated in 1956, and, more fully, in 1957, but it is not likely to be overcome until mid-1960. This delay was unjustified, says the report, which underlines the management's responsibility to achieve at a very early date a drastic improvement in the productivity of the aircraft maintenanee department notwithstanding the difficulty of negotiating with the trade unions involved.

Noting that the B.O.A.C. associate and subsidiary companies involve the Corporation in a substantial loss, the committee calls for a complete and urgent review of general policy towards the subsidiaries and of the individual operations of each of them. B.E.A. also loses money on all but one

* Report from the Select Committee on Nationalised Industries (Reports and Accounts). The Air Corporations. Including proceedings of the committee, minutes of evidence and appendices. Published by H.M.S.O. Price £1.







Only the VANGUARD

paces the jets at much less than half the cost

ALL ROUND Europe, and on record flights in Canada, the Vickers Vanguard has been logging block times which have proved that on short and middle distance routes it can more than hold its own with the jets. It has, in zero wind, beaten current jet schedules on sectors as long as London-Rome (955 st. miles). It has flown London-Gander (2,365 st. miles) in 5 hours 30 minutes, and Toronto-Montreal (335 st. miles) in a record 58 minutes in zero wind.

Other Vanguard block times are:

LONDON-BRUSSELS
230 miles in 45 minutes (5 m.p.h. headwind).

LONDON-HAMBURG
470 miles in 73 minutes—a record (17 m.p.h. tailwind).

LONDON-PARIS
224 miles in 41 minutes (zero wind).

PRESTWICK-KEFLAVIK
920 miles in 2 hours 35 minutes (zero wind).

KEFLAVIK-MONTREAL
2,360 miles in 6 hours 2 minutes (30 m.p.h. head-wind).

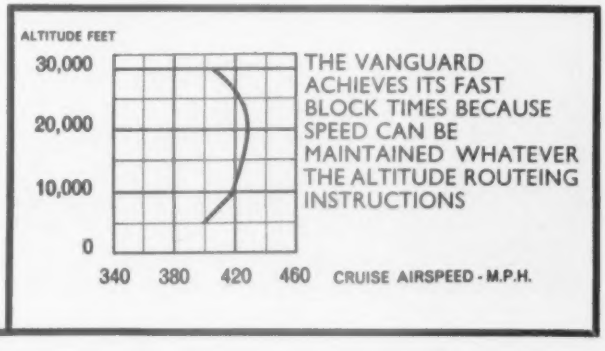
The Vanguard has achieved these block speeds at costs nearly one-third of those of comparable pure jet aircraft.

Recent U.S.A. figures show jet aircraft flight hour direct costs as 2.8 times greater than those of the Vanguard, and seat mile direct costs 2.6 times as great.

The Vickers Vanguard has, without doubt, the biggest profit potential ever offered to the airline industry—and it offers it at proved realistic competitive speeds.

The Economy Class cheap-fare capabilities of the Vanguard are at the forefront of the now established world movement for popular air travel. Only the Vickers Vanguard can bring these vast new markets to the Airlines on short and medium haul routes, at a substantial profit, and the Vanguard can do this with schedules as fast, if not faster, than any other aircraft.

Vanguard costs used in this comparison are to A.T.A. formula. Both the Viscount 745 and the Viscount 810 filed costs have been proved in practice to be substantially below such A.T.A. formula costs.



Of all the airliners only the Vanguard has all these features

425 m.p.h. cruising • Freight capacity 10 tons at normal densities • Full routeing and A.T.C. flexibility • Can use normal existing airfields • Quick turn-round • No airfield noise problems • Ten years' unique Vickers/Rolls-Royce turbo-prop experience . . . ***And it is 'Viscount' quiet.***

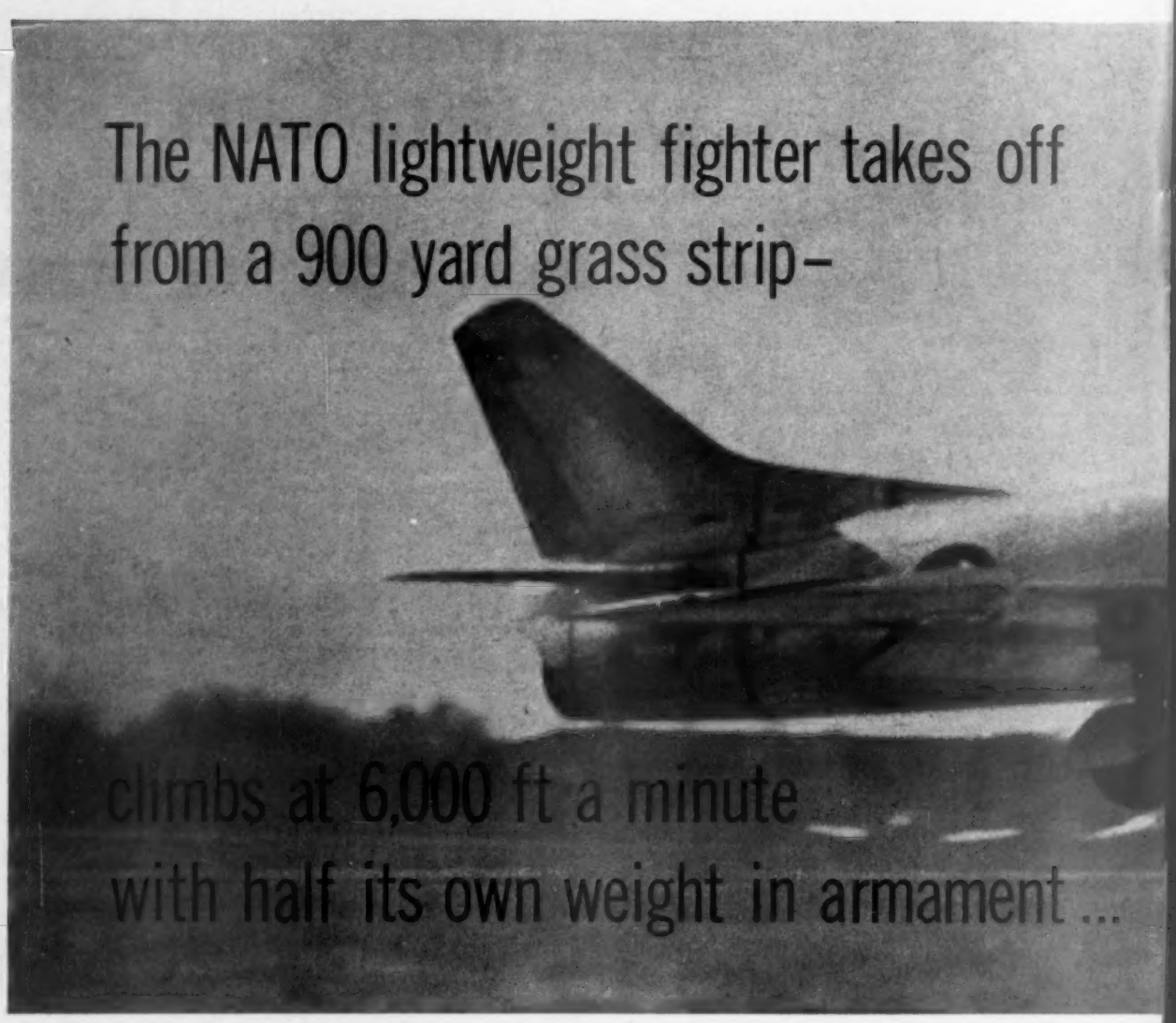
VICKERS VANGUARD

FOUR ROLLS-ROYCE TYNE TURBO-PROP ENGINES

• ***The airliner with the biggest profit potential ever offered to the operator***

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED WEYBRIDGE SURREY

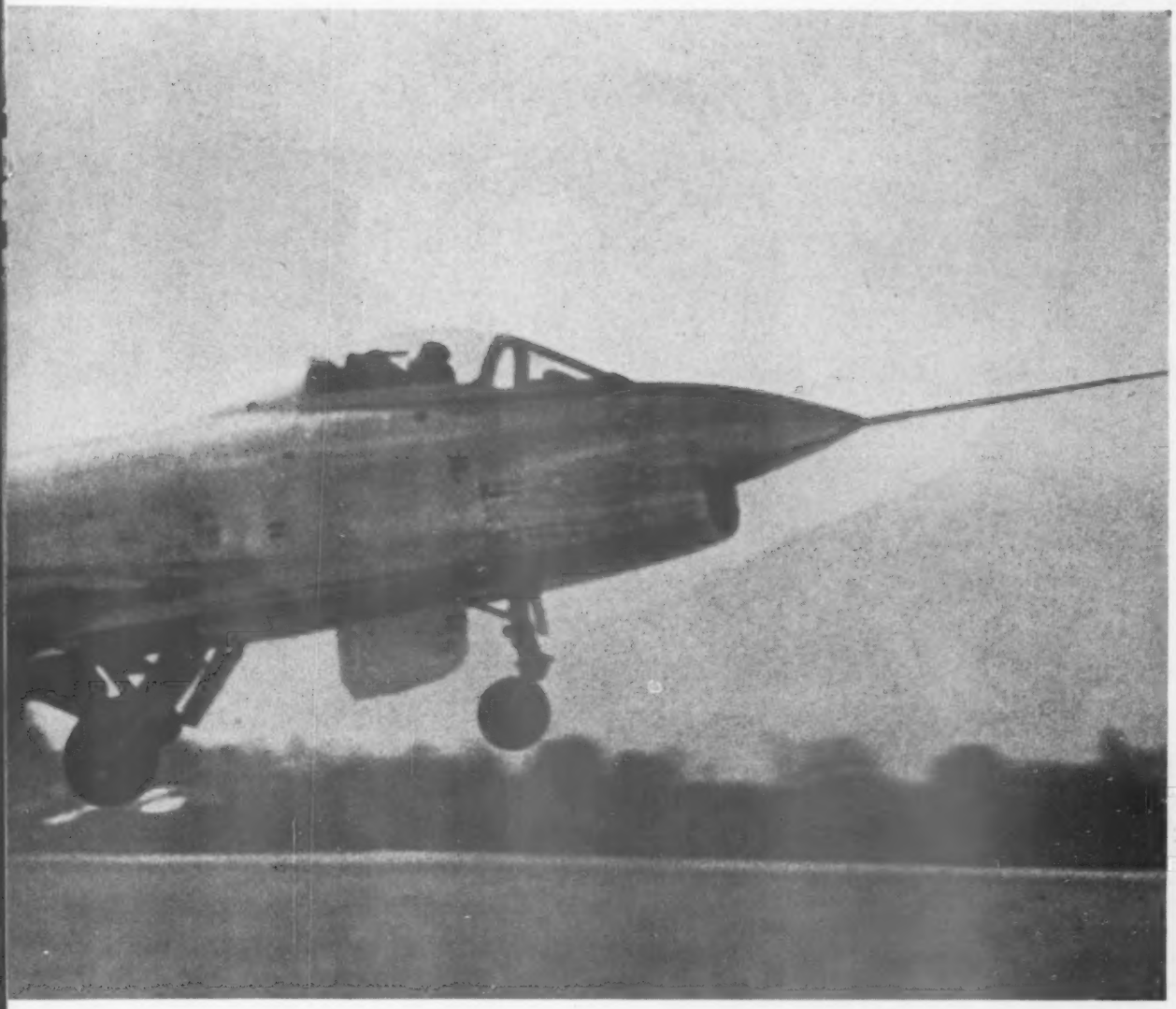
AT 627


The NATO lightweight fighter takes off
from a 900 yard grass strip–
climbs at 6,000 ft a minute
with half its own weight in armament ...

...AND BRISTOL SIDDELEY

One of the largest manufacturers of motive power units in the world, Bristol Siddeley Engines Limited produce the Orpheus. The Orpheus is the most advanced medium-thrust turbojet engine in service anywhere today and has been chosen for the NATO standard lightweight strike fighter—the Fiat G 91. Orpheus versions range from 4,050-lb thrust dry to 8,800-lb thrust with reheat and reach power/weight ratios of up to 6:1. They are already in service in 6 different aircraft types, specified for 8 others and are flying or licensed for building in India, Finland, Jugoslavia, France, Japan, USA, Italy, Germany.

BRISTOL SIDDELEY ENGINES LIMITED



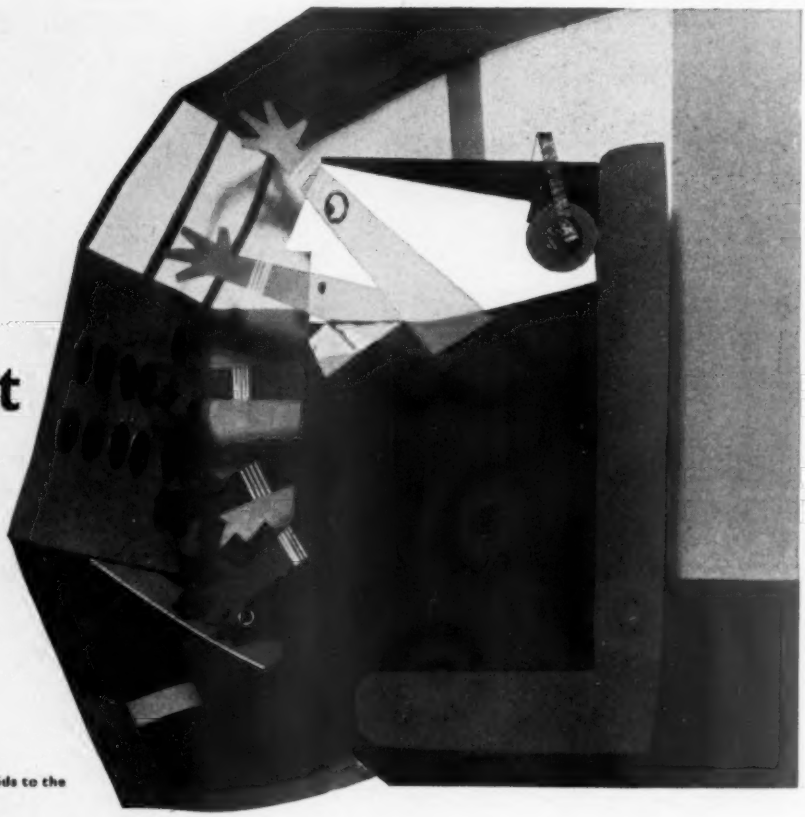
SUPPLY THE POWER

The Star Sapphire car is powered by a Bristol Siddeley 4-litre engine. Combining great power with exceptional quietness and luxurious comfort, the new Star Sapphire has a top speed of over 100 mph and an outstanding all-round performance.

The Bristol Siddeley Gamma rocket motor powers the Saunders-Roe Black Knight—Britain's highly successful space research vehicle. The Gamma delivers 19,000-lb thrust at altitude for a dry weight of only 700 lb—sends Black Knight 500 miles up into space.

The Bristol Siddeley Marine Proteus powers the "Brave" class Royal Navy patrol boats, built by Vosper Ltd. Three Proteus deliver a total of 10,500 hp—give these 96-ft. boats a speed of over 50 knots.

working pilot



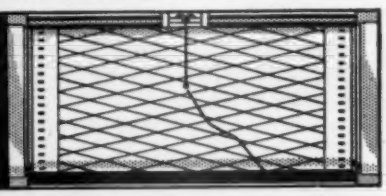
The IFALPA delegate speaking on point source aids to the ICAO Special Meeting, Montreal, February 1959

....**"It is a most unfortunate time to have to be fiddling with a receiver.** In order to tune in this type of station, you must switch off all of your other communications or else you will never pick up the Identification. One man in the cockpit is completely concerned with just one thing: tuning in the station – pressing his hands against his ears until he *can* identify it. The other man takes over the entire communications guard; continuously receiving clearances stepping the ship down, and also slowing it down; at the same time he is also operating a check list; this calls for conversation between himself and the other pilot if he can finish with his station identification. It is a very poor time to be distracted and pre-occupied with tuning a facility . . . there are eight holding stacks and of these six are non-directional beacons and the other two are intersections of radials from VORs. Holding on an intersection of two radials, you will be in a pattern something like this – one minute on this leg, a one minute turn, one minute on this leg, another minute turn and you are back where you started. On your Symbolic Display you centre the needle indicating the VOR radial from the left side; the VOR on the other side has a needle that is off-set, and as you approach the intersection, the needle on the other one will come into the centre—only at that one instant do you know exactly where you are. You then punch a stop watch and start a turn, using your directional Gyro and Turn Indicator—incidentally, you must hold your altitude with considerable precision because there are people above and below you in the stack. As soon as you leave this point both needles will be at various positions on the face of the dials and extremely difficult to interpret. As you come back into your pattern, the needle on the left should centre itself. If it does not you have wind drift, and you have a minute in which to correct it and bring it back into the centre.

'IS PICTORIAL PRESENTATION DESIRABLE?' I would say that it most definitely is. There is only one instant in this four minute pattern when you know exactly where you are, and that is only if within that minute you have been able to re-align yourself". . .

. . . but you always know where you are with

THE DECCA NAVIGATOR



THE DECCA NAVIGATOR
COMPANY LIMITED
LONDON

THE NAVIGATION SYSTEM FOR THE JET AGE

Air Transport . . . .

subsidiary, but hopes to make them all, except Jersey Airlines and Cambrian Airways, profitable in the long run. The results of subsidiary companies should be shown separately, and in detail, in the annual reports, says the committee.

B.E.A., the report suggests, should be improving its aircraft utilization rate and should be able to get operating costs down. In passenger load factor and output per employee—the other two criteria considered—B.E.A. results were reasonable. B.O.A.C. load factors were satisfactory, but utilization has not been good and output per employee and operating costs have been adversely affected by the employment of some 3,000 more engineers than necessary at London Airport.

One of B.E.A.'s problems, which received particular attention by the committee, is that of the services to the Scottish Highlands and Islands and to the Isle of Man, which cannot be justified on commercial grounds but which are undertaken as a social service. Provision for this loss should, the committee states, cease to be absorbed in the accounts of B.E.A. but should be made in the annual estimates of the appropriate departments.

Having looked into IATA's fare-fixing activities, the committee describes as "quite lunatic" the arrangement whereby complete unanimity is required for new fares to be agreed. Both Corporations "deserve credit" for advocating cheaper travel although they do not always agree on fares policy. The committee remains silent on B.E.A.'s policy of entering into pooling arrangements with most competitors.

Some of the strongest criticism in the report is levelled at the functioning of the inter-departmental Transport Aircraft Requirements Committee, which, in the past at least, has failed properly to fulfil its task of co-ordinating military and civil demands for new aircraft and to make plans for new British aircraft of all kinds. Some recent improvement is noted.

Also criticized is the extent to which the Minister of Transport and Civil Aviation has assumed non-statutory powers, to a degree far in excess of that envisaged by the statutes setting up B.E.A. and B.O.A.C. Relations between the Corporations and the Minister are, nevertheless, both "warm and mutual." More co-operation between the two Corporations might be possible in future, but there was no immediately obvious case for merging departments, or the entire Corporations.

The report, which runs to some 450 pages, includes much interesting factual material—which cannot be summarized here—in the form of appendices, in addition to the transcript of the evidence presented verbally by the Corporations, the M.T.C.A., the M.o.S., the Treasury and the A.R.B.

North Atlantic Traffic Trends

THE statistics for IATA carriers on the North Atlantic for the second quarter of 1959 are tabulated here. The previous table in this series appeared in THE AEROPLANE AND ASTRONAUTICS for May 22, 1959. As we noted last week, the statistics show that passenger traffic increased by 12.5% over the same quarter of 1958, indicating that the rate of growth has now returned approximately to "normal" after the 1958 recession. The quarter was notable for the increase in freight by nearly 50%. Also indicative of the growing interest in freight was the increase in all-freight services from 468 to 614.

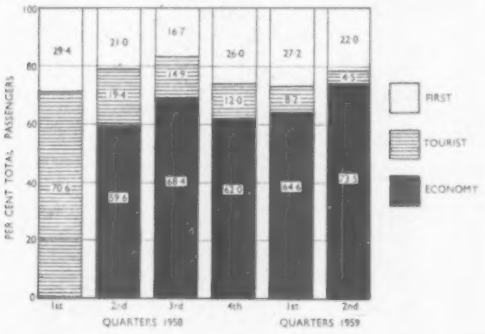
Another striking figure in the quarterly result is the percentage of tourist-class travellers, which dwindled to an all-time low of 4.5% of the total traffic. At the same time, economy class increased to a record 73.5%. A diagram below shows the way in which the quarterly passenger totals have been divided between the three main classes (first-class includes de luxe), since the first quarter of 1958.

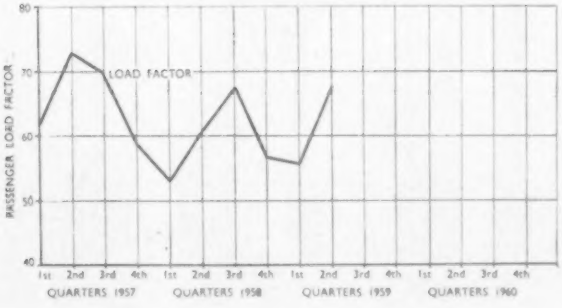
Economy class travel was introduced in the second quarter of 1958, since when this class has gained a wide measure of support at the expense of tourist class. One hidden factor influencing these statistics, however, is the fact that several airlines no longer offer tourist class at all. Throughout the period, first-class traffic has remained a fairly constant proportion of the total; during the winter months, when holiday travel is at its lowest, this class can be seen to become relatively more important.

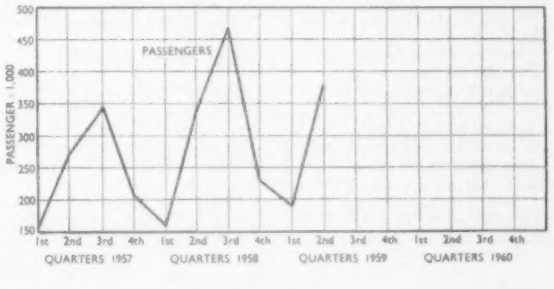
Other results on the North Atlantic since the beginning of 1957 are plotted on the three curves reproduced here. They will be extended and reprinted each quarter.

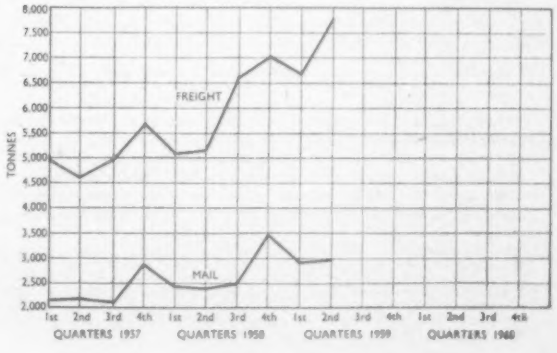
2nd Quarter, 1959

	East-bound	West-bound	Total	% Change 1958
Scheduled flights	4,137	4,112	8,249	—4.3
Seats offered	281,523	278,059	559,582	+1.2
Revenue pass.:				
First	46,199	36,608	82,807	—
Tourist	9,713	7,374	17,087	—
Economy	164,223	113,436	277,659	—
Total	220,135	157,418	377,553	+12.5
Pass. load factor, % ..	76.1	56.6	67.5	+ 6.8
Freight, kg.	3,999,617	3,730,640	7,730,257	+49.8
Mail, kg.	1,627,680	1,255,189	2,882,869	+20.0









COMMONWEALTH SYMPOSIUM

Blue Streak as a Satellite Launcher

ONE of the great advantages we have as a nation interested in space-research is that we already possess, as part of our military programme, a large rocket vehicle of outstanding performance. This is the de Havilland Blue Streak LRBM, examples of which are expected to be tested next year over the extended Woomera range.

Although structural specimens of the 70-ft.-long 10-ft.-diameter missile have been apparent in the test towers of de Havilland factories at Hatfield for some time, little information about it was available until the presentation last week at the Commonwealth Spaceflight Symposium of a paper by Mr. G. K. C. Pardoe, chief co-ordinator (ballistic missiles), of de Havilland Propellers. Despite security restrictions on the performance of the basic missile, Mr. Pardoe has been able to pack into his paper a good deal of pertinent information about the prospects of Blue Streak as a vehicle for satellite launching, including a number of ingenious solutions concerning the design of upper staging.

Aims and Facilities

Before dealing with the engineering problems, Mr. Pardoe stresses that the attraction of space-research lies not only in the field of geophysics but in direct commercial applications which are already in sight. The 24-hr. satellite is a well-quoted example of direct application to telecommunications; but this is by no means the only solution to this particular problem, as a pattern of satellites revolving closer to the Earth might well be superior.

It must surely be regarded as important, he says, that a nation such as our own is kept acquainted with the knowledge of how to move in new regions. It might well be that some fundamental military applications of space-flight will become apparent; already (in America) consideration is being given to projects dealing with surveillance, reconnaissance and communications. There is an obvious desirability of knowing at least how to project equipment into space in this respect.

The British Commonwealth has a tremendous advantage in its terrestrial coverage. In addition to the launching sites already under construction at Woomera, there were several desirable places at which space vehicle launching sites could be established with advantage. Commonwealth territory can, and does, provide unique facilities for tracking. The radio-telescope at Jodrell Bank is an important United Kingdom facility.

An important base has been established at Singapore which already provides valuable tracking information and, of course, in Australia, too, equipment has been set up to play an important part in space exploration. Britain and Australia are already busily engaged in the construction of the Blue Streak ballistic missile system and its associated testing and launching sites, and in Canada there is a large amount of experience with guided missiles and aircraft.

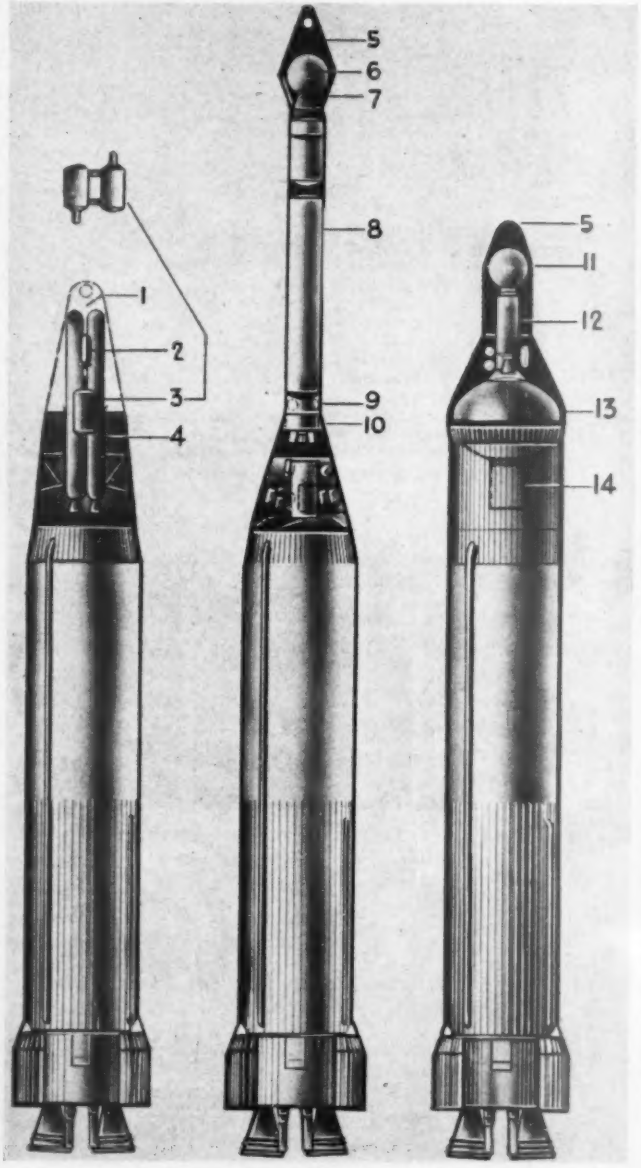
We have then the nucleus of the required effort firmly established within this group of nations, with the potentiality to expand this in many directions, as required.

Adapting the Vehicle

Arguments for using as much existing equipment and facilities as possible brings Mr. Pardoe to his central theme, that of adapting Blue Streak as a satellite launcher. It is fully appreciated, he said, that the greatest concentration of energy should be incorporated in the upper stages and that an optimum design would make use of exotic high-energy propellents; thus, in considering contemporary equipment, we are not presenting a case for the best overall performance.

Aiming at simplicity in the first example, let us consider what might be achieved by the addition of a simple solid second stage to Blue Streak. The second stage is formed by a twin solid rocket propulsion unit, each of the rockets being based on an existing design.

Instead of the more orthodox location of the payload at the head of the propulsion unit, one might divide the payload into two canisters located in the manner shown, indexed with



Three possible methods of adapting the Blue Streak as a satellite launcher, with (left to right) a solid rocket 2nd stage; an orthodox Black Knight 2nd stage; and a re designed Black Knight upper stage with same engine unit but "doughnut" tank system. Latter vehicle could be used alone or with addition of a third solid stage to orbit at greater distances.

Key.—1. Nose cone (jettisoned at first-stage cut-off); 2. Two attitude correctors and spin stabilizers; 3. Dual satellite package; 4. Launch rails; 5. Nose cone (jettisoned at first-stage cut-off); 6. Payload (volume 33·5 cu. ft.); 7. Separation line (springs or gas jets); 8. Basic Black Knight; 9. Additional pressurized H.T.P. equipment (provides control during separation and coasting periods); 10. Fairing and support structure (replacing existing fins and pods); 11. Payload; 12. 3rd stage solid rocket; 13. "Doughnut" tank; 14. Black Knight engine bay.

the twin motors. This gives convenient packaging of the second stage and payload, and a more compact configuration. Clearly, alternative payload locations are possible.

It can be seen that a light fairing is suggested, stretching from the front over the second stage and payload. This fairing is incorporated to reduce drag in the early ascent phase and reduce kinetic heating input to the forward equipment. On leaving the atmosphere, or on completion of first-stage burning, the fairing may be jettisoned by the compressed-air or H.T.P. unit shown diagrammatically at the front end of the fairing. In either case the unit gives a small lateral force sufficient to pivot the fairing on the rear outer edge, away from the then exposed second stage.

Between the second stage and the front tank section of the first stage, a bay is shown which will house an inertial guidance system. The capabilities of this simple two-stage vehicle are strictly limited to close-orbit satellites, and the guidance developed for a military rôle should be more than adequate to control the first-stage flight.

With the simple second stage, terminal guidance would be rather difficult to incorporate. It is suggested that differential deflection of the rocket motor venturis would provide an appropriate rate of rotation of the second stage, thus stabilizing it during its burning time. Therefore, to achieve the necessary accuracy of the payload in orbit, reliance will have to be placed entirely on the accuracy of the first-stage guidance system.

There is nothing new or clever about this proposal for a solid upper stage. The most important feature would be its early availability. If it is assumed that the total weight of the second stage and payload is of the order of 8,000 lb., then a suitable velocity increment from the motors could be obtained with an overall payload of about 1,000 lb.

One can, therefore, conclude that the existing Blue Streak missile, with virtually no mechanical or system changes, together with an extremely simple second stage, is capable of placing a payload of some 1,000 lb. in a 300-mile circular orbit.

It would not, however, be sensible to embark on a comprehensive space programme based on the limited potential of a solid stage alone.

Black Knight

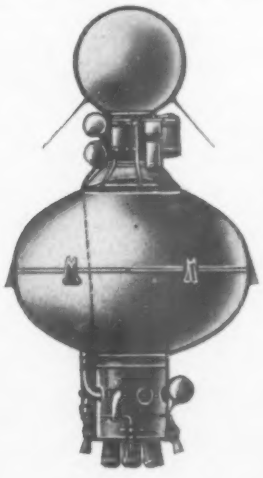
Staying on the theme of availability, thoughts immediately turn to the use of the R.A.E. test-vehicle, Black Knight, as a possible second stage for Blue Streak. An accompanying illustration shows how this combination might look when used as a two-stage vehicle with a nominal payload.

Black Knight has a quadruple chamber rocket system, using H.T.P. and kerosene as propellents. Each of the four chambers produces 4,000-lb. thrust at take-off, giving a combined take-off thrust of 16,000 lb., and this total thrust rises to over 18,000 lb. outside the atmosphere.

Normally the length of Black Knight is some 35 ft., and its maximum diameter is 3 ft. The distribution of the propellent tankage is with the H.T.P. to the rear and the kerosene forward, with a small bay containing pipe-work, reducing valves, etc., in between the two tanks. Guidance and control equipment is located in a short bay in the forward end of the kerosene tank, in the front of which the various types of payload can be installed.

It has been suggested that this payload could be about 1,000 lb. This load is well within the capabilities of Blue Streak, and the combination looks quite attractive. Its main merit, of course, is that the second stage already exists.

The long, thin, structure of Black Knight sitting on top of Blue Streak will dictate careful investigations into the design of the adaptor between the two stages, and obviously new dynamic bending loads are produced on the forward tank section of Blue Streak, which may or may not demand some structural changes. The long, thin, combination will produce different flexural characteristics of the complete vehicle during first-stage burning, which in turn will reflect some changes in the autopilot system. Although the moment of inertia is higher with the second stage and payload in place, larger excursion angles of the first-stage motors may well be involved in certain wind shear conditions during flight through the atmosphere.



Black Knight, re-modelled with a "doughnut" tank, but retaining the same four-chamber engine unit, would become Blue Streak's second stage. The satellite payload is placed on top.

Mr. G. K. C. Pardoe demonstrates a model of the Blue Streak in the guise of a satellite launcher. In the background can be seen the redesigned Black Knight second stage, which fits inside the vehicle's extended nose.

The use of a liquid propellent in the second stage poses the problem of in-flight ignition, not only after separation at the end of burning of the first stage, but also for interrupted burning during second-stage propulsion which is almost certainly required. Fortunately, H.T.P. (used with a catalyst) and kerosene should provide comparatively trouble-free ignition.

At the present stage, when we may be about to embark on serious space vehicle production, it is obviously essential to consider the largest and most efficient second and third stages which could be carried aloft by Blue Streak. In this respect improvements over the basic Black Knight should be investigated, since in its present form, this vehicle is much smaller and lighter than the take-off boost potential of Blue Streak. Whilst there is great merit in the availability and reliability of Black Knight it does fall short of the ideal size and thrust characteristics in relation to the main stage.

Redesigned Tanks

There exists, however, a very attractive alternative whereby the best of both worlds might be combined: the focal point of a requirement for a good second stage is an accurate and reliable propulsion and control system. The complete propulsion bay of Black Knight is an extremely well-engineered piece of equipment; it is suggested, therefore, that this bay should be taken complete and used in association with a modified tankage. Such a deviation from the basic Black Knight would incur the minimum risk of development trouble, since a change of tankage shape need not be critical.

Mr. Pardoe's paper shows a solution on these lines. Two hemispherical tank domes are placed end-to-end, their separation by a parallel section of tank being determined by the limiting volume (and therefore weight) which can be lifted by Blue Streak. The same maximum diameter as Blue Streak is thus produced in the second stage; and on consideration of the division of volume within the tankage of the second stage to allow for the H.T.P./kerosene burning ratio, it is suggested that the more orthodox lateral separation diaphragm could well be replaced by a longitudinal cylindrical type diaphragm. The kerosene, being the smaller volume, could be contained within this central tube, and the H.T.P. could be in the outer torroidal container.

This layout has been lightly referred to as a "doughnut"

configuration. A higher pressure would obviously have to be maintained in the kerosene tank than that in the H.T.P. tank, to avoid compressive stresses on the central tube, but the pressures in both tanks are comparatively small and this should present no problem.

Some care will have to be taken in the design of the attachments of the ends of the kerosene tank to the domes of the H.T.P. tank to allow for appropriate flexibility. It is suggested that the rear end of this kerosene tank could be made to the 3-ft. diameter of the Black Knight propulsion bay, and the axial loading between the propulsion bay and the forward bay leading to the payload could be effected through this kerosene tank wall, assisted by pressurization of the H.T.P. tank.

Looking at this second stage in relation to the overall configuration, a transition bay has been shown in front of the Blue Streak tank. This bay could contain an inertial guidance system, as well as encompassing the Black Knight propulsion bay, as shown. This transition or guidance bay could be projected forwards so that attachment to the second stage would be immediately behind the outer edges of the second-stage maximum diameter of the tankage.

To minimize kinetic heating input to the H.T.P. tank, the forward fairing leading back from the payload could be brought to a slightly larger diameter than the second-stage tank domes and a double-wall insulation thereby provided. This forward fairing, encompassing the payload as well, could be a very light fairing and separated (after leaving the atmosphere) in the same manner as that for the simple solid stage fairing.

Behind the rear dome of the second-stage tank, and around the outside of the Black Knight propulsion bay, there is obviously plenty of volume where the second-stage control equipment and even some guidance equipment could be located. Small ancillary rockets would be required in the second stage, for reasons discussed later, and these too could be located in the space.

This equipment would be exposed after main stage separation, but would be protected from kinetic heating and aerodynamic loading during the ascent phase through the atmosphere. The maximum amount of structural weight would, therefore, be left behind with the first stage.

Ahead of the front dome of the second-stage tankage, space could either be left for further equipment—or there could be a direct adaptor attached either to a third stage or directly to the payload. Only a two-stage propulsion vehicle is shown in the illustration, and a nominal payload is shown attached directly to the front of the second stage.

From an overall configuration viewpoint, such a modified tankage for the second stage could well be lighter than a longer structure and the compact shape could easily be blended in with the Blue Streak vehicle: there would also be good design flexibility when fitting payload configurations on the front. The thrust-to-weight ratio at the beginning of second stage ignition could be 0.8, or even substantially lower in certain circumstances, and so with the 18,000-lb. thrust available *in vacuo* at the beginning of second-stage ignition, this could mean a second stage of some 22,000 lb. in weight.

Taking, for example, a nominal 300-mile circular orbit, calculations based on the increased tankage indicate that a payload mass of some 2,000 lb. could be expected. This represents a substantial improvement over the 1,000 lb. suggested for the conventional Black Knight combination and it may well be that the added development work necessary to make and prove the different tankage, compared with the Black Knight vehicle, would be justified. It should be borne in mind, too, that the manufacturing technique of this new tankage would be based very closely on experience with Blue Streak.

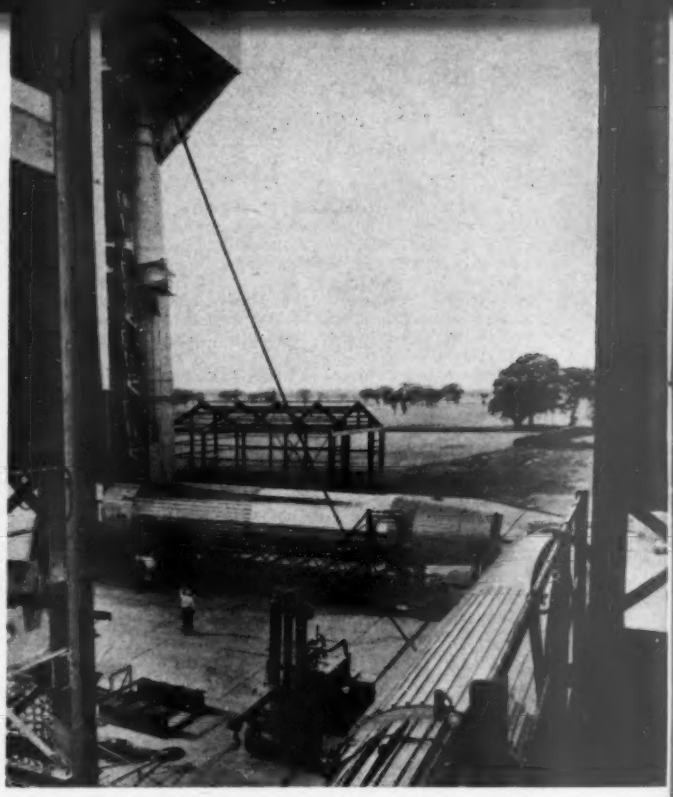
Problems of Zero-g

There are further features of this "doughnut" configuration which are worth briefly reviewing. During second-stage phase a problem exists under zero acceleration conditions (during a coast period) whereby the liquids of the propellents gradually separate into a froth-like composition, due to the absence of any local gravity.

This dissociation of particles of the fluids starts very shortly after zero-*g* is established. Obviously, this poses a considerable problem when the propulsion system needs to be ignited after the coasting phase, since there are no liquids—only froth—to feed the pumps.

One of the obvious ways to overcome this is to provide a subsidiary solid rocket acceleration facility for a short period before the engines need to be ignited. But there is evidence to show that quite a substantial acceleration needs to be maintained for a comparatively long time in order to regenerate sufficient liquids within the tankage to start up the pumps ready for the next stage of burning.

Small solid propellent rockets could be used for this, but the presence of a tank of H.T.P. is rather tempting when one considers that extremely reliable and efficient small-thrust rocket power can be obtained by passing H.T.P. over a catalyst through a simple nozzle. Pulsed operation of these nozzles (each of, say, some 40 to 80 lb. thrust) could first be used to effect a separation of the upper stages from the second stage, and at a later time could be used for providing the small acceleration phase necessary to regenerate the propellents in liquid form, ready for the start of delayed ignition.



Structural specimens of the de Havilland Propellers' Blue Streak L.R.B.M. deployed below the test towers at Hatfield.

Properly phased, a continuous acceleration period could be produced between the first-stage thrust cut-off, bridging the gap between this and the beginning of ignition of the second stage after separation has been achieved. By this means minimum risk of cavitation on the second-stage turbopump system would be involved.

During coasting, economically it may be desirable to adjust the attitude of the rocket so that the rear end (or front end, for that matter) faces the Sun, thus minimizing radiation heat input to the propellent tanks. This could be achieved either by selected use of the small H.T.P. rockets discussed earlier, or probably more sensibly by the introduction of a further set of very low thrust H.T.P. rockets located around the second stage. Pulse operation of these in relation to the space gyro system of the second stage would give the required attitude control.

A second-stage antenna could also be housed around the Black Knight propulsion bay, together with a miscellaneous array of instrumentation, telemetry equipment, command and destruct break-up receivers, etc., which inevitably accompanies a ballistic vehicle of this nature. Finally, there would be space in this region for the electrical power system for the second stage; this again could be the basic Black Knight system.

Looking ahead a little further, should it be necessary or desirable to fit a significant third propulsion stage, in order to project a smaller payload deeper into space, then it would seem comparatively simple to fit such a stage on to the top of this "doughnut" Black Knight second stage. Again, this arrangement is shown in the diagram, where a simple solid rocket third stage is arbitrarily taken for convenience.

Other than stating that even larger payloads and performance could be gained by designing an optimum second stage, no further detailed consideration to these more advanced concepts will be given here. The point is made, therefore, that the payloads discussed are by no means the limit; something of the order of just over a ton may well be the maximum capacity of Blue Streak as a first stage.

Deliberately, little mention has been made in detail in this paper of the satellite or payload itself. The Government have initiated design studies on the form this payload might take. This work is being carried out largely by Government Establishments and Universities throughout the country with, it is hoped, appropriate consultation with industrial experts.

Given the advantage of single-mindedness of purpose, concludes Mr. Pardoe, a British team could produce a worthwhile and reliable vehicle of which the British Commonwealth could be proud.

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HANDLEY PAGE **DART**

Herald

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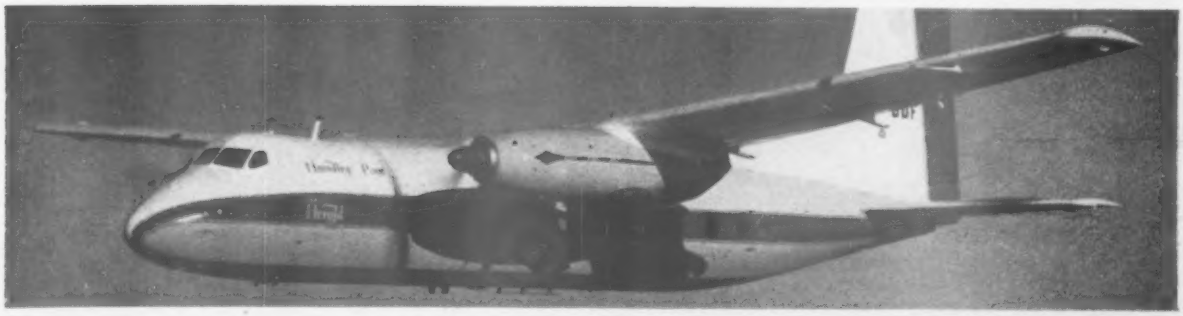

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COMMONWEALTH SYMPOSIUM . . .

Taking as his theme "Britain's Place in Interplanetary Exploration," Mr. John E. Allen, head of the Aerodynamics, Projects and Assessment Department, A. V. Roe and Co., Ltd., examines in his paper the problems of laying down a space-programme

Shaping the Programme

SEVERAL choices are open to us, says Mr. Allen, depending on the money we feel we can afford, and also to a large extent on the care with which we organize our efforts, and on the imagination we display in making the best of our talents. One possibility, which we have already rejected, would be to stay out completely. Alternatively, we might adopt a modest minor plan by continuing theoretical and imaginative writings, analysing the flights of others space vehicles and making instruments to be carried in other people's rockets; we might, however, embark on a major programme in which we make, and fly, our own space vehicles. Many believe that this is the only course which will enable us to keep in step with modern technology. Then, eventually, we should be able to play a full part in interplanetary exploration, contributing to it the knowledge of our scientists and the skill of our engineers, and gaining thereby valuable returns in technique and ultimately in scientifically fruitful enterprises.

Such a major programme is not on the books at the moment. The reasons are well known: cost, manpower, incentives, and lack of progress in some associated areas of technology. We have been standing at the edge of this barrier for too long with no means of bridging it. Mr. Allen's aim is to attempt to design the missing bridge.

He is sure there are many possible designs and the one that is eventually built will look very different from his proposed design, for it will embrace ideas and structures proposed by many others.

There are many ways of approaching a possible 10-20-year space programme for the Commonwealth. For example, one could seek objectives embracing commercial or economic utility, military requirements, or prestige ventures. This approach is not likely to be fruitful, because these objectives are not sufficiently well defined at the moment, though perhaps in two years' time they may be, and because of this neither decisive military requirements nor commercial projects can be assessed.

The approach will therefore have to be different. Mr. Allen's assumption is from the outset that we do decide to embark on a complete but necessarily restricted programme, for the simple reason that Britain lives very much by designing and making ingenious devices needed for complex engineering and scientific enterprises, and space flight is one such outlet very closely related to much work already in hand.

Hypersonics

In order to demonstrate this approach, Mr. Allen selected a hypothetical high-speed aircraft which he said had a performance of particular interest to the Commonwealth. Its specification would be as follows: range, 12,000 miles; crew, 2; cruising speed, Mach 9.0 (approximately 6,000 m.p.h.); propulsion, external combustion ramjets; payload, 6,000 lb.

There have been many projects for aircraft to fly half-way round the World—presumably the "ultimate aeroplane"—including those of Sänger (1933), Dornberger (1955), and the work in the United States on Dyna-Soar, which may well represent the first practical engineering steps towards a solution. Mr. M. B. Morgan, in a recent discussion at the R.Ae.S., suggested that the 12,000-mile freight and passenger aircraft might appear some decades hence using some of the techniques learnt in getting spaceships up and down through the Earth's atmosphere. This, then, is an interesting project to consider for the present purpose.

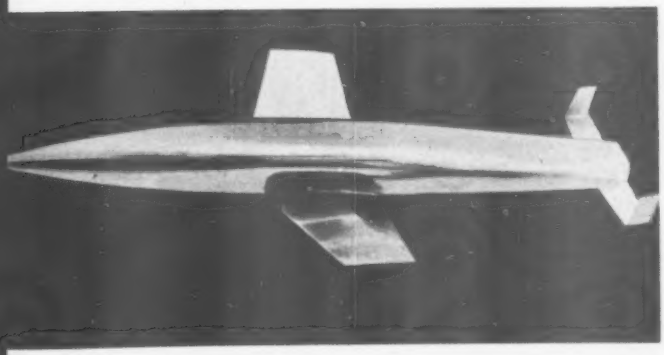
The development steps envisaged were broadly these: 1, a research aircraft; 2, photographic or radar reconnaissance; 3, delivery of important freight en route by an automatic, winged, slip vehicle; 4, high-speed transport for key personnel (6-8 persons); 5, launcher of satellites or other space craft; and 6, a larger vehicle with increased capacity for passengers and freight.

Mr. H. R. Watson, technical director of Armstrong Whitworths, holds a model of the A.W.A. satellite vehicle which represents latest British design thinking on manned hypersonic flight.

The status of such a project is, of course, highly speculative now as we grope our way towards supersonic transports (Mach 3.0). It may be that this type of vehicle may never mature, or, if it does, it may fall by the wayside like the airship.

In retrospect, the drive for improvement in aeronautics has been largely stimulated by the simple concept of ever-increasing speed. Mr. Allen has always been a little sceptical of the eventual wisdom of this approach, bearing in mind that safety and economics are ultimate arbiters of many aeronautical trends. He would not like his proposal to be taken out of its context; it is merely an illustration of a possible trend closely related to certain astronautical developments.

It follows from this tentative discussion that sooner or later the Aircraft Industry must decide on the balance of its efforts



Model of the rocket-powered "antipodal" bomber, first conceived by Eugen Sänger in 1933, and the subject of intensive design studies in Germany as a potential weapon from 1937-1942. Object was to carry a man and bomb-load more than half-way round the World at near orbital speed.

involving a whole range of radically different vehicles which are already, or will soon be, technically feasible. The list includes helicopters, subsonic economy transports, jet transports, manned military aircraft, guided missiles, and spacecraft.

Growth Potential

In Mr. Allen's long and stimulating paper (the full text runs to 23,000 words), there are many points of general interest. A brief analysis, for example, is given of the beginnings of other technological revolutions in this century, namely, the growth of aeronautics, the coming of atomic energy, and the development of the guided weapons industry. Comparisons are made from these examples to the present stimulating period, in which space-flight is slowly but surely entering our scientific and industrial lift. An attempt is also made to visualize the effects of a full space programme on Commonwealth science and industry as a whole. His conclusion is that, providing it is planned carefully, space flight can be taken in our stride alongside all our other programmes, eventually providing not only data but helpful stimuli to many related areas of research with fruitful commercial developments.

Other Astronautical Papers

AT the 9th Congress of the International Astronautical Federation in Amsterdam last year, members of the U.S. Select Committee on Astronautics and Space Exploration interviewed many foreign scientists and engineers to obtain their views on collaboration in space-research. The results of this survey have now been published in a staff report† which concludes that "a highly competent, friendly, and critically needed source of scientific manpower is available outside the United States."

"There appears to be a real desire among key British officials," the report continues, "to work co-operatively with the United States and develop particular British specialities as partnership ventures. It was suggested, for example, that the United Kingdom could build remote control probe vehicles for Moon or Mars shots while the United States continued to develop the main boosters. . . ."

Soft-landing instruments on the Moon has been the subject of a pilot study by a small group of the B.I.S., who envisage the use of rocket-braking in conjunction with a radio-altimeter (THE AEROPLANE AND ASTRONAUTICS, May 8, 1959, p. 553). The paper by Mr. Dennis S. Carton (The College of Aeronautics, Cranfield) concentrates on the propulsion side of the problem, and concludes that, very approximately, 1,000 lb. of Earth launching vehicle mass are needed for each pound required by the Moon-landing vehicle. A large part of the paper is devoted to outlining an optimization procedure that will ensure that thrust levels, and other propulsion parameters, do in fact result in a *minimum* landing vehicle.

The study has not been limited to solid propellents. Liquids having good storage properties are considered, hydrogen peroxide/hydrazine being an example of a self-igniting pair.

Both collision course and grazing ellipse landing techniques employing terminal rocket braking are examined in detail; the former requires less rigorous attitude control and is less demanding on propulsion. A thorough mathematical appendix is included and as the first known paper on the subject, it is all the more praiseworthy.

It is quite impossible in the space available to deal at length with the many other important contributions to this unique symposium. Dr. A. P. Willmore of University College, London, produced an excellent paper on "Satellite tracking by optical methods" in which two techniques of precise orbital observation of Earth satellites were proposed, one photographic and the other photoelectric. The results of such observations are of substantial value in geodesy.

The feasibility of using thermal fission rockets for launching space-vehicles was considered by Dr. O. H. Wyatt of the Hawker Siddeley Nuclear Power Company. The gain of specific impulse from choosing a low molecular weight propellent must be balanced against the greater reactor and fuel storage weights. Reactor sizes, using uranium 235 or plutonium 239 fuel and graphite or beryllia moderator, have been calculated at various voidages,* as have the weights of several hypothetical reactors. Graphs show the equivalent cut-off velocity and range against all up weight for nil and 20,000 lb. gross payloads. In conclusion, a comparison with present and future chemical propellents illustrates the superior performance of nuclear rockets for all-up weights exceeding 100,000 lb.

In his paper on "Heating problems of entry into planetary atmospheres," Dr. D. J. Shapland, head of Avro's Aerophysics Group, outlined the basis of the problem by considering typical re-entry trajectories for ballistic and winged vehicles. Aerodynamic characteristics, shape, flight path and aerostatics of the atmosphere were considered in some detail; also, methods of dealing with the intense heating rates, suggestions being given for the design of manned and unmanned re-entry vehicles.

In a companion paper, Dr. D. E. Bailey, head of the Avro Assessment Group, dealt with "The Recovery of Earth satellites," and described re-entry for winged vehicles. Mr. P. R. Wyke, head of the Chertsey Research and Development Group, A. V. Roe and Co., Ltd., discussed "Space Navigation."

Commonwealth Facilities

Woomera as a satellite tracking and launching station was the theme of a contribution from the Australian Weapons Research Establishment, presented by Mr. H. J. Higgs, W.R.E. representative with the Ministry of Supply in London. Canadian research and industrial facilities were surveyed by Mr. E. Wall, Guided Missile Division, the de Havilland Aircraft of Canada.

Messrs. S. K. Kumar and R. L. Macarthy sent a paper on behalf of the Indian Astronautical Society outlining research the group had conducted with small staged solid rockets in conjunction with the Indian Defence Department. Details were given of a three-stage rocket employing a fast-burning propellent which would be capable of attaining a velocity of about 25,000 ft./sec. after launching from a large plastic balloon above 40,000 ft. Calculations had shown that for a take-off weight of 1,000 lb., the rocket could carry a payload of 5 lb. to an altitude of 3,000 miles.

† "International Co-operation in the Exploration of Space," Staff Report of the Select Committee on Astronautics and Space Exploration. U.S. Printing Office, Washington, 1958.

* Spaces for working fluid."

Hard Pads for Titan

FORMATION of an Activation Division to act as integrating contractor for the operational Titan weapon system in the field was announced on June 21 by the Martin Company of Baltimore. Working under the direction of the U.S.A.F. Ballistic Missile Division, its primary function will be to ensure the weapon's operational readiness in accordance with Air Force schedules. Its immediate concern will be to administer and co-ordinate the work of various contractors engaged in the construction of the Titan training facility at Vandenberg.

Particulars of the Titan launch complex have recently been given by the Martin Company. A typical operational site will consist of three sunken cylinders, or "silos," connected by servicing tunnels. The 90-ft. Titan will be stored in the main silo which extends approximately 165 ft. underground. One of the adjoining cylinders will contain electronic gear, a power unit, air conditioning and hydraulic equipment; and the other, rocket propellent.

During launching, the control centre housing members of the launching crew will be the only occupied portion of the underground complex. When word for launching is given, concrete doors on the surface will slide open and the Titan will be elevated into the firing position on its blast-proof concrete launching pad. The missile is to be fired only minutes after the launching order is given. Some distance away, a radar tracking dome will also appear from underground.

Pyramid Experiments

AN interesting sidelight to the paper on the revolutionary "pyramid" re-entry aircraft given at the Commonwealth Spaceflight Symposium is the fact that model experiments have been carried out by Armstrong Whitworths in free-flight as well as in wind-tunnels. Experiments began with balsa wood test models less than 1 ft. span launched by means of an ingenious rubber catapult, and several successful flights have been achieved in this way (picture of model, page 93).

Success depends entirely on the person adjusting the launching mechanism for if the model is not released at the correct angle, it will merely tumble and crash.

Operation of the actual vehicle under re-entry conditions requires a configuration that creates high drag for slowing down in the upper atmosphere but at the same time gives adequate lift and stability on the landing approach. This the A.W.A. "pyramid" vehicle appears to give, due to the unique combination of a pyramid-shaped upper structure and a delta planform. Landing speed of the full-scale vehicle would be about 85 m.p.h. (that of the X-15 is about 185 m.p.h.).

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ANNOUNCEMENT

THE GOODYEAR TYRE AND RUBBER CO. (G.B.) LTD., in conjunction with ELECTRO-HYDRAULICS LTD., are pleased to announce a manufacturing agreement whereby Electro-Hydraulics are producing all Goodyear-designed wheel, brake and associated hydraulic equipment formerly produced at Wallasey.

Under the new arrangement Goodyear retains responsibility for design, modification and repair of all equipment save the hydraulic brake controls, for which Electro-Hydraulics will be the design authority and the supplier.

Goodyear's facilities at Wolverhampton and Hounslow are being expanded to provide increased sales and service in the U.K. and to further assist Goodyear's world-wide field organisation with sales and service in the Export markets.

Aero tyre production is not affected by the Agreement and will continue at the Wolverhampton Factory.

This action is looked upon by Goodyear as a consolidation of their position in the Industry and by Electro-Hydraulics as an extension of their service, supplementing hydraulic systems and undercarriages with hydraulic brake controls.

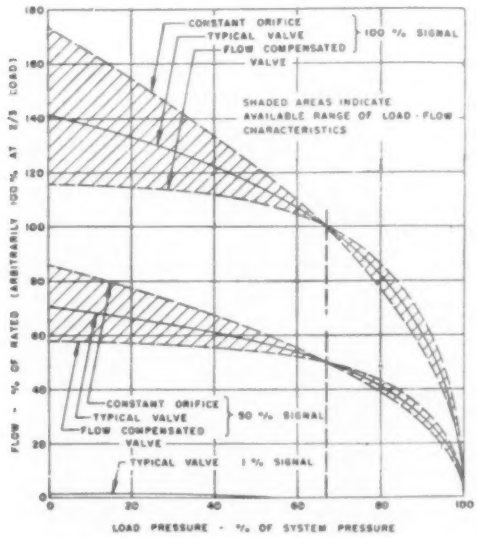
A Servo-valve from Dowty

ONE of the key features of the control system of a modern guided missile or aircraft is the servo-valve. Its function is to position heavy loads with precision, as for example in drives for gimballed rocket engines, aerodynamic surfaces, and radar antennae. In industry, it has wide application in the computer control of machine tools.

Wherever servo systems are required capable of fast response together with outputs above one horse-power, it is customary to employ hydraulics since the high torque-to-inertia ratio, obtainable with the hydraulic jack or motor, is superior to that of the electrical equivalent. At the same time, electrical signalling is essential for data transmission in control systems employing, as they do, the magnetic tape in the machine tool industry and the radio wave in the missile and aircraft fields.

The function of the electro-hydraulic servo-valve is to control large output horse-powers delivered to a jack or motor, proportional to electrical input signals of only a few milliwatts.

At Dowty Equipment Ltd., Cheltenham, production has started of a precision-built servo-valve which is being manufactured under licence from Moog Servocontrols, Inc., of New York. The valve is the product of many years' experience by Moog.



Above, flow control valve, load flow characteristic.

Various servo control valves have, of course, been produced in this country for many years but, depending as they do on the use of a torque motor, for some applications they lack sufficiently fast response. In the Moog valve, this deficiency is overcome by the use of a "flapper" which is, in effect, the motor armature.

The servo-valve consists of a polarized electrical force motor and two stages of hydraulic power amplification, as shown in the accompanying diagram. The motor armature or flapper passes through a tubular flexure pivot which also acts as a seal between the electro-magnetic and hydraulic sections.

At the end opposite to the motor, the flapper passes between two nozzles, creating two variable orifices between the nozzle tips and the flapper. Pressure oil is supplied to these orifices through two fixed upstream orifices and the intermediate chamber pressures are vented to either end of the output stage spool. The spool is of conventional four-way design and is spring centred. Output flow from the valve, at a fixed valve pressure drop, is proportional to spool displacement.

As a signal is applied to the motor, a force is developed upon the flapper, causing it to pivot and move between the nozzles. This motion causes one orifice to open as the other closes, resulting in a differential pressure between the nozzle chambers. The pressure difference, acting upon the nozzle projected areas, results in a feedback force upon the flapper to balance the motor force. The pressure differential also acts upon the second-stage spool, resulting in a displacement and, hence, output flow proportional to electrical signal input.

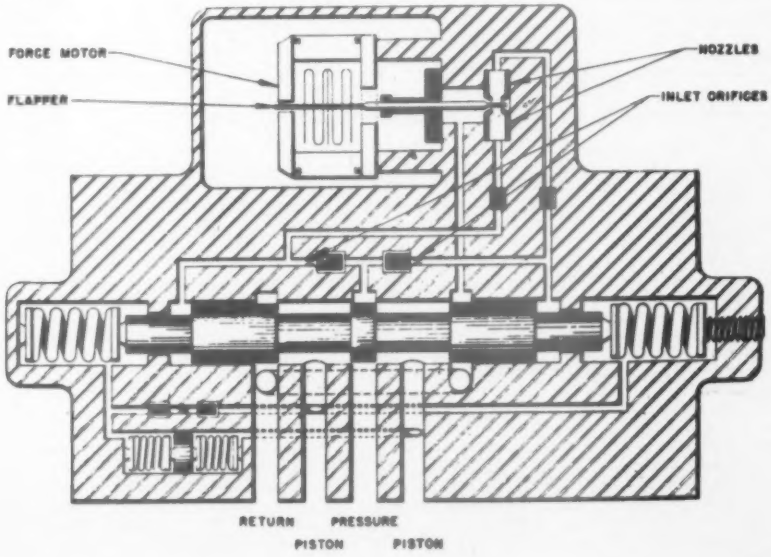
True proportionality exists between spool position and the electrical input signal because of an exact force balance at the flapper. This balance is achieved through cancellation of the spring rate of the flexure tube pivot by the negative force gradient of the permanent magnet motor.

This patented rate cancellation feature provides a stabilized hydraulic amplifier in which gain is independent of supply pressure variations. Further, dynamic response is enhanced since maximum spool velocity can be produced whenever flapper force unbalance exists.

Manufacturing the Moog Valve

Manufacture of these servo-valves requires a very high standard of precision engineering. At the Dowty works new test rooms have been built which, with their chequered blue and red composition flooring and cream-painted walls, have a distinctly clinical appearance. In these air-conditioned, temperature-controlled rooms, assembly and testing of the Dowty Moog valves proceeds as an integral operation.

First the straightness and roundness of bore and the clearance diameter of the spools are checked by means of air gauging. Underlap and overlap of spool and bushing is controlled in accordance with the customer's specification, and where



Right, diagram of the Dowty Moog flow control valve with load pressure feedback.

N

necessary parts are ground finished to an accuracy of 0.00005 to 0.00007 in. using air gauge vernier setting.

In an adjacent room, all parts used in the valve are ultrasonically cleaned. The parts are then assembled on scrupulously clean Formica-topped benches which are completely enclosed except for a cowled section of transparent plastic in the front for the operator's hands. A light draught of air is continuously exhausting through the cowl as a means of dust exclusion.

Testing goes on in stages throughout the assembly of the servo-valve. To keep the oil in the test circuit clean, it is constantly recycled through an elaborate system of 5-micron filters between the pump room and the adjacent assembly and test room where the servo-valves are bolted down on consoles.

To reduce the risk of oil contamination a periodic count is taken on the basis of 50-millilitre samples, to ensure (1) that particles 1 to 25 microns across maximum dimensions do not exceed 40,000 particles in number, of which no more than 1,000 may be metallic particles of 10 to 25 microns in size; (2) that particles larger than 25 microns in size across maximum dimensions do not exceed 500 particles in number; and (3) that fibres larger than 500 microns in length do not exceed five particles in number. Each morning the hydraulic test circuit is run continuously for at least 30 minutes to clean the system prior to making the analysis.

After this the servo-valves to be tested can be bolted down in position on the test consoles and checked in turn for flow rate, frequency response, resolution, linearity and hysteresis. Filters are included in the valve to minimize contamination.

In the test procedure the first-stage amplifier is set up independent of the second stage of the valve, and between testing of the first and second stages a shake test and hot and cold temperature tests are accomplished on each unit. The shake test produces lateral forces of some 30 *g* and in the vertical plane 10 *g* The final test is a frequency response test.

All valves are tested in accordance with the particular installation in service. Thus the mounting pad and holding down bolts must be faithfully reproduced during testing, for such is the accuracy demanded that the magnetic influence of the surrounding metal must be taken fully into account.

Since Moog Servo Controls, Inc., began developing these valves in 1950, they have produced over 100,000 mostly for aircraft and missiles. Their current production rate exceeds 15,000 valves per year.

The large measure of experience Moog have acquired with servo-valves of this type—which is their sole occupation—was the deciding factor in Dowty taking up the licence for manufacture in this country. To obtain the necessary manufacturing and test experience from scratch would have been exceedingly costly and time consuming.

At Cheltenham the experimental stage was reached just over a year ago and production is now under way. The degree of precision demanded in this work is high and each valve requires individual attention, so that the man who carries out the assembly must also test and adjust the valve to the particular standard demanded by the specification.

Because of these exacting requirements, the initial production rate is comparatively low, though Dowty's expect soon to be producing 50 per month. With present factory facilities, the limit would be about 2,000 per year.

A finished A.I.D.-approved servo-valve suitable for missile or aircraft application costs about £150, which reflects the rigorous manufacture and testing procedures involved. Similar valves for industrial application work out slightly cheaper.

Gliding Notes

by Dr. A. E. Slater

THE excellent custom of inviting foreign participants to fly in national gliding championships continues to spread. Philip Wills' participation in the Dutch Championships has already been described in THE AEROPLANE AND ASTRONAUTICS: since then David Ince has flown in the French ones, Tony Goodhart in both the French and Italian Championships: and Martin Mulhall, of Dublin Gliding Club, who was in Elmira during the United States Championships, did the next best thing and crewed for one of the American competitors.

David Ince, who took an Olympia 419 to St. Yan, described his experience to the Kronfeld Club. The 22 French competitors all flew Breguet 901s, to facilitate choosing an international team for next year, and were not allowed radio, oxygen or artificial horizons. Tony Goodhart had the Fauvette (Breguet 905) which he has now bought—the 5th to be built: the Belgian gliding champion, M. Xhaet, had a German Ka-6: and the Italians brought their new two-seater Bonaventura, whose high speed and consequent wide turning circle was unsuited to the thermals which, Ince said, were extremely narrow most of the time.

The French marks for races were in proportion to speed, not the square of the speed as has been the recent custom; they also set race tasks which were fairly easy, so as to avoid putting undue strain on their pilots. So on the first day's task, a 100-km. out-and-return to Moulins and back, everyone succeeded except the Bonaventura, which nearly did. Next day, on a 100-km. triangle, Ince made his final glide through a downcurrent and undershot the finishing line, though he crossed the Loire which borders the aerodrome.

On the third day Tony Goodhart, with the French pilots, Labar and Barbera, went east along the Jura, picked up a cu-nim, and glided out from it along the Swiss frontier, Labar making the best flight of 229 km. Ince, who landed beside Lake Geneva, had much trouble convincing the Swiss authorities that he had come from the West, not the East. Next day produced a cu-nim overhead of St. Yan in which M. Weiss, of France, reached 12,000 ft., and Xhaet had an exciting time when his turn-and-slip packed up—his airspeed indicator went "round the clock" but the Ka-6 still held together in one piece.

The classic flight to St. Auban, involving the use of waves over the mountains along the east side of the Rhône valley, was about to be set one day when the French changed their minds and cancelled it because the very strong wind might produce dangerous "rotors" in the wave regions; the risk is that accelerations in these rotors can break not only gliders but human blood vessels, and are liable to shift their position suddenly, besides being not always marked by cloud.

The contest finished with a "fantastic" task of a 300-km. triangle on a day when thermals went up to only 1,500 ft. above ground; the best pilot got just half-way round. In the whole contest Goodhart finished about 5th and Ince somewhat lower.

* * *

TONY GOODHART took his Fauvette (Breguet 905) to the Italian Championships after flying it in the French ones. Here, by contrast, a great variety of types were flown, and there was only one other foreigner, M. Marsat from France. The meeting was at Rieti, in the mountains north of Rome, and was, he says, most efficiently run. Aero-towed launches were done by Stinsons.

Goodhart was the only pilot to complete the first day's task, an out-and-return of 150 km. along the mountains. On the second day, with "free distance" announced, everyone went south-eastwards along the Appennines—an anxiety-making route because few of the vallevs had any flat ground at the bottom: but although he was able to get down into a stubble field, a rock hidden in the stubble suddenly knocked four feet off one of the Fauvette's wings. The authorities ruled that a competitor could not re-enter the contest with an entirely new wing, but a unanimous petition by all the Italian pilots induced them to change their minds.

However, on his next flight Tony Goodhart emerged from a cu-nim to see a complete cloud cover below, presumably stuffed with mountains; he avoided them by going east but had to land in rough country which put the Fauvette out of action for the rest of the meeting. By then he had scored a total of 1,730 points, enough to put him in 17th place among the 24 competitors. Leonardo Brigliadori became Italian champion with 4,760 points earned with a Urendo. Second was G. Silva with a Canguro, and third G. Ferrari with a Skylark.

* * *

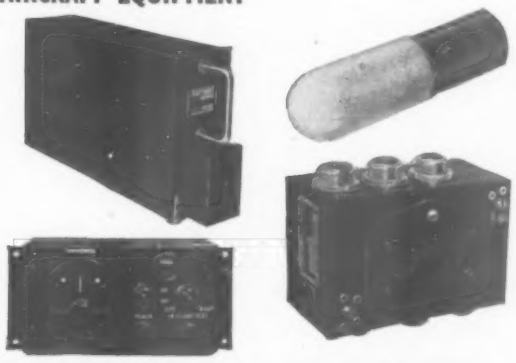
NO British visitor took part in the German Championships, though one had been invited. The 34 entries included one from Buenos Aires. Ernst-Günther Haase, who became World Champion in Poland last year, won the Open Class with his HKS3, earning 3,579 points. After him came W. Kunz with a Mü 22, 3,180 points; R. Spanig; R. Kunz, and in 5th place among the 13 entries, R. Lindner, flying the new plastics sailplane Phoenix, with 2,282 points. He brought it from Nabern, Teck.

Heinz Huth was winner among 21 Standard Class entries, 16 of whom, like him, flew the Ka-6 type, which won the international OSTIV prize last year for the best Standard Class machine. The contest was held at Forchheim, near Karlsruhe, but this does not mean that next year's World Championships will be held there; a more likely site is near Coblenz, but it has not yet been settled.

Final seeding for the British team in the World Championships has resulted in a list of six pilots who are (alphabetically): A. J. Deane-Drummond, H. C. N. Goodhart, G. A. J. Goodhart, D. H. G. Ince, G. H. Stephenson and J. S. Williamson.

The fatal accident to Wolf Hirth, whose obituary notice appeared in THE AEROPLANE AND ASTRONAUTICS on August 21, has been revealed as due to his having had a heart attack while flying at Lo-150; it was his second flight that day, and he had already been in the air 10 minutes.

AIRCRAFT EQUIPMENT



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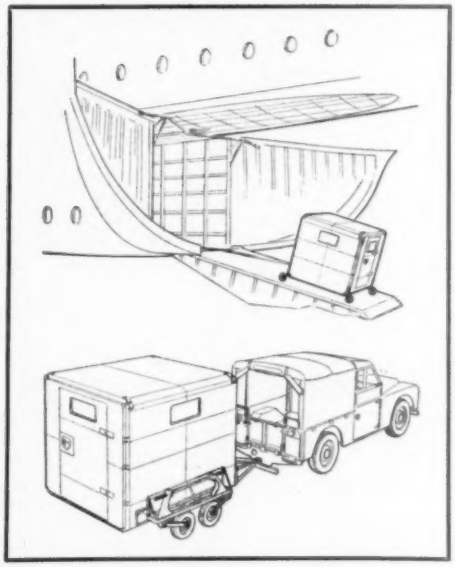

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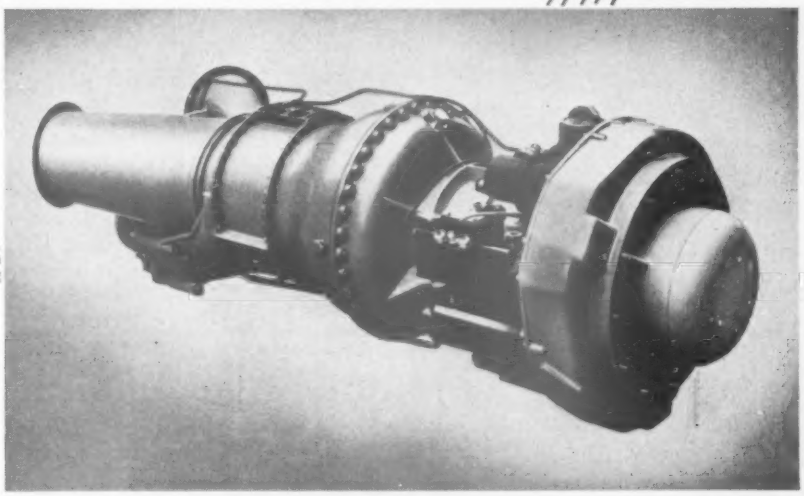

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M.2A

Personal Flying

Flying the Mooney Mk. 20A

by John Fricker

WHITE-TOPPED, white-winged and its sleek fuselage a glossy two-tone blue, the elegant Mooney Mk. 20A stood brand-new on its stubby nosewheel undercarriage at Croydon, the navy blue dope of its G-APVV registration barely dry. A couple of brief test flights had marked its re-emergence, after assembly, from the chrysalis state conferred upon it by an air-freight flight across the Atlantic, and it was now mine to sample, and to deliver, in the process, to its owner, Mr. Donald Carnegie, at Luton.

Its rakish contours and distinctive swept-forward fin were not entirely new to me. During the visit of a 1957 model Mk.20 demonstrator, with the less powerful 150 b.h.p. Lycoming O-320 flat-four engine, I had flown this American four-seater at Southend for about an hour, and had been greatly impressed by its speed and general handling. The comfortably upholstered cabin of G-APVV, however, with its new carpets protected by paper, conveyed little sense of familiarity, although the reasons for this were explained by the representative of Travelair, who are the Mooney dealers.

The 1959 model Mooneys have redesigned instrument panels which are a considerable improvement over the earlier aircraft of the series, although the positioning of the individual instruments is slightly haphazard. The central position in the flight group on the left of the panel, for example, is occupied by the clock, while the A.S.I. is tucked away on the extreme left of the bottom row. No V.S.I. or turn-and-slip indicator was installed in G-APVV, as a standard Mk. 20A, and the single-needle altimeter was pathetically inadequate. Spaces are provided, however, for additional instruments.

A comprehensive range of engine instruments are grouped to starboard of the panel, although a regrettable omission, in view of the prevalence of carburetter icing in American light aero-engines, is an intake manifold temperature gauge. On the other hand, full night-flying lighting is fitted as standard for all the instruments, together with navigation, landing and cabin lights. Layout of the starboard panel was completed by the control box of the £400 Lear ADF-12E radio compass.

Top centre of the panel is the selector unit for the Narco Mk. V VHF transceiver, which offers a 90-channel crystal-controlled transmitter, and a 190-channel receiver for a weight of 9.5 lb. and an ex-factory cost of about £370. This set operates through a built-in loudspeaker in the roof of the cabin, although head-set points are provided on each side of the front panel. Above the VHF control box are mixture and master-switch plungers, flanking the usual American key-type ignition switch.

Below are the two large plungers for throttle and pitch control, each with the now-standard U.S. vernier control system knobs. A large central button unlocks the plungers when pressed, for them to be pushed or pulled for major changes of power or pitch, but for taxi-ing and fine adjustments the knobs may be turned clockwise to screw the plungers forward, and vice-versa. Like most American gimmicks, this system is convenient and easy to use once you get used to it, although it almost drove me to a frenzy, when flying formation in the '57 demonstrator for some air-to-air photographs. Continual moderate changes of power involved constant cramping pressure on the button while moving the throttle back and forth.

Photographs copyright "The Aeroplane and Astronautics"

The attractive cockpit of the 1959 Mooney Mk. 20A is shown in its standard form, as it arrived in the U.K. The new "W"-shaped control wheels are apparent, together with the central undercarriage and flap levers, and the handle on the port side for the retractable step.

Externally indistinguishable from the Mk. 20A, the Mooney Mk. 20 has a lower-powered Lycoming O-320 engine and is slightly cheaper in initial cost. The Mk. 20 shown is a 1957 model which was also flown by the author.

It is necessary, however, to keep reminding oneself that the miniature American businessliners are not meant for such frivolities as formation flying, but are practical and economic vehicles for high-speed travel. The practicability of the Mooney is such that the Mk. 20A, with a 180 b.h.p. Lycoming O-360-A1A flat-four engine, cruises at a guaranteed 165 m.p.h. T.A.S. at its economic setting, carrying four people on less than 7 Imp. gallons of fuel per hour.

Having sorted out the panel, I noticed a further change from the 1957 Mooney in the replacement of the former dual push-pull control wheels by low-slung and more comfortable "W"-shaped yokes. Dual rudder pedals are fitted, with toe-pedals for the hydraulic mainwheel brakes on the port set. A parking knob is on the instrument panel, and signifies the main requirement for the brakes, since the nosewheel is steerable through the rudder pedals for taxi-ing.

The two front seats are rapidly adjustable for leg length and for cabin access, which is now also aided by a retractable step below the starboard wing walkway. The wing root is already so close to the ground that the step, which disappears into the wing fillet after 2½ turns from a handle in the cockpit, allows dignified entries and exits through the single starboard door by the most hobble-skirted women passengers.

Behind the rear bench seat is a large baggage compartment, which has a shoulder-high external access hatch on the side of the fuselage, and a maximum capacity of 120 lb. The rear seat lifts out for access to the wing centre-section, which requires periodic inspection and varnishing. This is because the Mooney employs a very unusual mixed construction of a "flexible" wooden wing and tail unit on an all-metal fuselage, the latter having a semi-monocoque tail boom and an alloy-clad steel tube cabin section.

Wood is employed, in conjunction with a suitable NACA aerofoil section, to get a truly laminar-flow wing, with an extremely smooth overall finish, on which much of the Mooney's efficiency depends. Built up on a single spar, the wing is dipped in a plastic sealing compound after construction, to seal it from climatic effects, and with the specified maintenance, is guaranteed for the life of the aircraft.

One final unusual feature of an unorthodox design is the all-moving empennage. The rear-fuselage cone, on which are mounted the swept-forward fin and tailplane, pivots for longitudinal trimming via a small hand-wheel between the front seats. It seems a slightly drastic way of varying the tailplane incidence, but is claimed to reduce drag and improve stability.

Once settled in the slightly narrow cabin, with its green-tinted windows offering a good all-round view, except where a very thick pillar is formed by the junction of the windscreen and door, I managed, with the aid of my notes from the previous trip, to bring the Lycoming into life. A three-way fuel cock on the floor in front of the left-hand seat (which in its most forward position effectively blanks off the selector) is switched to one of the two 14½ Imp. gal. wing-root tanks, or the 12½ gal. fuselage tank, and two primes given by the throttle.

A stab of the unguarded starter button does the rest, and after checking for the correct oil pressure, a twist of the throttle

vernier gives enough power on tarmac, for taxi-ing. The voice of the controller at Croydon came through the roof loudspeaker loud and clear above the subdued rumble of the engine, and the Mooney steered easily with light foot pressure for moderate turns. A touch of toe brake helped in turns of tighter radius, and then more power was needed as the aircraft moved on to grass.

With a fairly short wheel base, the Mooney pitches quite a bit on rough surfaces, and with its rather hard undercarriage shock absorption, achieved by rubber "biscuits" in compression, gives the impression that it is primarily intended for runway operation. The undercarriage seems very robust, however, and the short legs seem well able to withstand rough treatment, although the passengers get bounced around a good deal on grass.

With the pointer of the trim indicator strip next to the little wheel set mid-way to "take-off," and the dashboard-mounted lever for the manually-operated flaps pulled out to the first of its two extended positions, I gingerly pushed the throttle forward. The acceleration across the rough turf was invigoratingly rapid at full power of 28 in. Hg. and 2,700 r.p.m., and a slight tendency to swing to port was easily checked by a small amount of right rudder.

Progressive back pressure on the control wheel at about 50 m.p.h. resulted in an unstick about 10 m.p.h. later, after a commendably short run. The airspeed rapidly increased to the recommended climbing speed of 95 m.p.h., which results in a very steep attitude, and I let G-APVV soar well clear of the ground before wrestling with undercarriage retraction.

Landing gear actuation in the Mooney is done mechanically by a direct linkage from a long lever between the pilots. This is an excellent idea for a light aeroplane, being very quick in operation (two seconds in this case), light, cheap, and requiring no stand-by or secondary system. Like all manual undercarriages, however, that of the Mooney requires a definite knack for its effortless operation, in changing the effort half-way through the travel of the lever from a pull to a push, against the springs in the system. Locking and unlocking is very positive, via a sliding handle on the lever, and after an hour or two in G-APVV, I had the operation thoroughly buttoned up. It might present some difficulty for a woman, however, or anyone else lacking a strong right arm.

With a full load, the Mk. 20A will climb at well over 1,000 ft./min., and go on up to 22,000 ft. or so, but on my initial flight, I settled for about one-tenth of that to cruise round London to Luton. Throttled well back to 23 in. Hg. and 2,300 r.p.m., which is the most economical power setting, and with the manual cowl flaps closed, G-APVV still streaked along at about 150 m.p.h. I.A.S., but at its optimum altitude of 10,000 ft., it will return 165 m.p.h. T.A.S. at a similar 55% power, covering no fewer than 23.5 a.m.p.g.

This is really travelling for a total of 180 b.h.p., which if applied at sea level, results in a maximum speed of 190 m.p.h. Alternatively, 75% power will give 180 m.p.h. T.A.S. at 7,500 ft., which is only 3 m.p.h. less than the "never-exceed" or red-line speed. This low limitation seemed the only curious feature of the Mk. 20 series, which are stressed to the normal positive load factor of 3.5*g* (actually to +3.8*g*), since Vne could, of course, be exceeded in level flight. Also, the airframe is so clean that a very slight dive at cruising power will soon result in reaching 183 m.p.h.

The maximum manœuvre speed, above which full application of the controls may result in overstressing, is 150 m.p.h., and it is advisable to slow down to this speed in severe turbulence. As there is now a 250 b.h.p. version of the Mooney series, the Mk. 21, with a similar airframe and a considerably faster cruising speed, it would be interesting to know why the limitations on the Mk. 20A could not be made higher. They are presumably connected with the original limitations for the Mk. 20, which received an automatic C. of A. on being re-engined with the 180 b.h.p. Lycoming.

Control forces of the Mooney are commensurate with the load factors, the ailerons and elevators requiring a moderate effort for their operation at normal cruising speeds, and lightening up substantially at lower speeds. Harmony is good, and the rudder can virtually be forgotten in the air. With positive all-round stability, the Mooney gives a very pleasant impression of "solidity" in the air which coupled with the extremely low noise-level makes it an excellent cross-country vehicle.

Changes of trim with differing power, speed or flap setting are small, and the tiny wheel for varying the tailplane incidence is adequate, despite its very low gearing. Aft trim helps to keep the nose up as power is reduced, as I found after reaching Luton and climbing up clear of the circuit to try some stalls. On throttling back for a clean stall, the rather faint undercarriage warning horn was joined by the stall warning horn at about 60 m.p.h. I.A.S., and the two continued until the breakaway came quite suddenly, with a certain amount of buffet and a mild drop of the port wing, at 50 m.p.h. or so.

Loss of height was small, and hard backward pressure was needed to obtain a clear-cut stall. In the approach configuration with everything down and a little power, the stall-warning horn began its plaintive bleat at about 55 m.p.h. I.A.S., the breakaway following, again with a port wing drop, at 45 m.p.h. No aerodynamic warning was apparent, but lateral control, with the aid of wing-root spoilers, remained to some degree right down to the stall.

No real complaint can be made about the Mooney's low-speed characteristics, except that they are not really usable on landing, since second position of flap extension gives insufficient drag for a steep approach. For landing, the undercarriage can be lowered at 120 m.p.h. or less, with little change of trim, and half-flap can follow at 100 m.p.h.

Aft trim is then required to reduce speed still further, but a comfortable approach attitude with full flap necessitates about 80 m.p.h. on the A.S.I., if the nose is not to be too high for comfort. With flaps of greater power this could be reduced by 10 m.p.h. or perhaps more, and the Mooney motored on to the ground quite comfortably in the usual tricycle manner. After several hours in G-APVV, assisting with the conversion of the five P.P.Ls in the Carnegie family, I found that I could drag the beautifully stable Mooney in at 70 on finals, and still get a reasonable float for a full-stall touch-down at about 55 m.p.h.

For England's small grass fields the Mooney is therefore slightly underflapped, but, in the course of about eight hours' flying, I landed it in several quite confined airfields of about 800 yd. maximum length. I also got to like it very much, as a smooth, efficient, fast and economical vehicle, a view which has been amply confirmed by the Carnegies during their recent trips in it to Norway and France.

One of the most interesting aspects of its appeal is the success with which Mooney Aircraft are now challenging the bigger light aeroplane companies in the U.S. This is because it is $10,000 cheaper than the nearest equivalent business aeroplane of a similar power, and production has been one per day since last October. The basic price of the standard Mk. 20A aircraft, delivered to the U.K., is £7,270, while the lower-powered Mk. 20 is £6,850, also duty-paid.

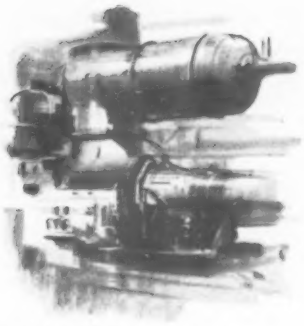
LEADING PARTICULARS

DIMENSIONS.—Span, 35 ft., length, 23 ft. 2 in.; height, 8 ft. 4½ in.; wing area, 167 sq. ft.

WEIGHTS.—Empty (equipped), 1,415 lb.; pilot and three passengers, 680 lb.; fuel and oil, 315 lb.; baggage, 120 lb. (100 lb. with full tanks); gross, 2,450 lb.

PERFORMANCE (Mk. 20 in parentheses).—Max. speed, 190 m.p.h. (171 m.p.h.); cruising speed, 75% power, 180 m.p.h. (165 m.p.h.); cruising speed, 55% power, 165 m.p.h. (150 m.p.h.); initial climb, 1,150 ft./min. (900 ft./min.); service ceiling, 20,000 ft. (17,200 ft.); range at economical cruise, 1,075 miles at 10,000 ft.; take-off run 600 ft. (725 ft.); landing run 575 ft.

In this view of G-APVV, the Mooney Mk. 20A which was the subject of this article, can be seen the retractable step, the ventral ADF fairing and movable empennage.



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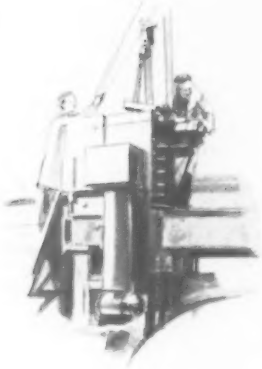

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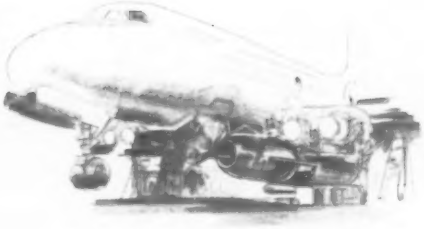

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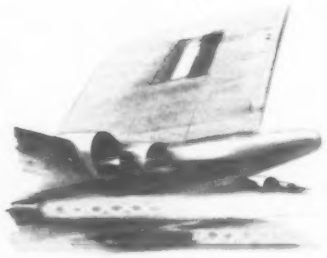

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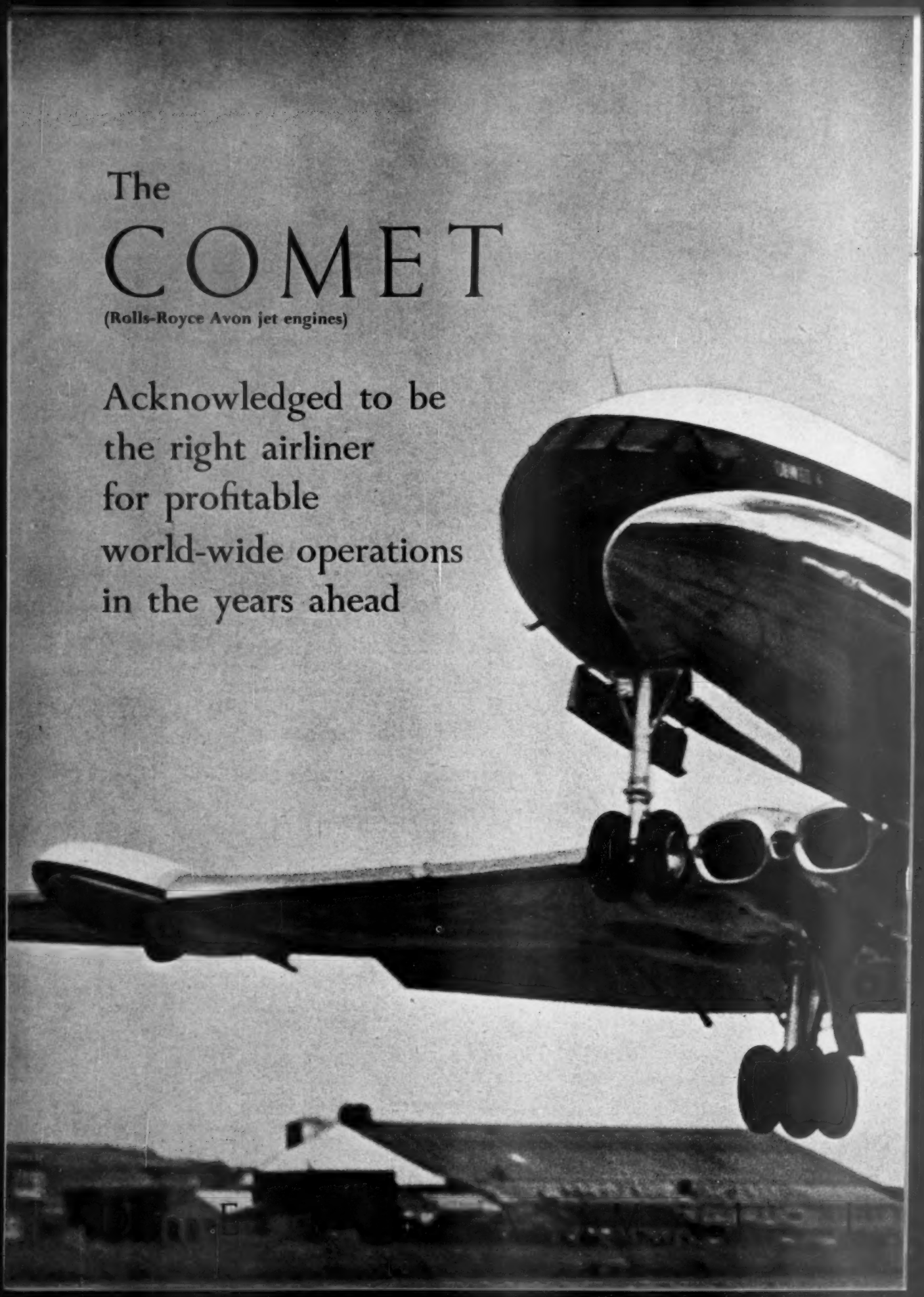
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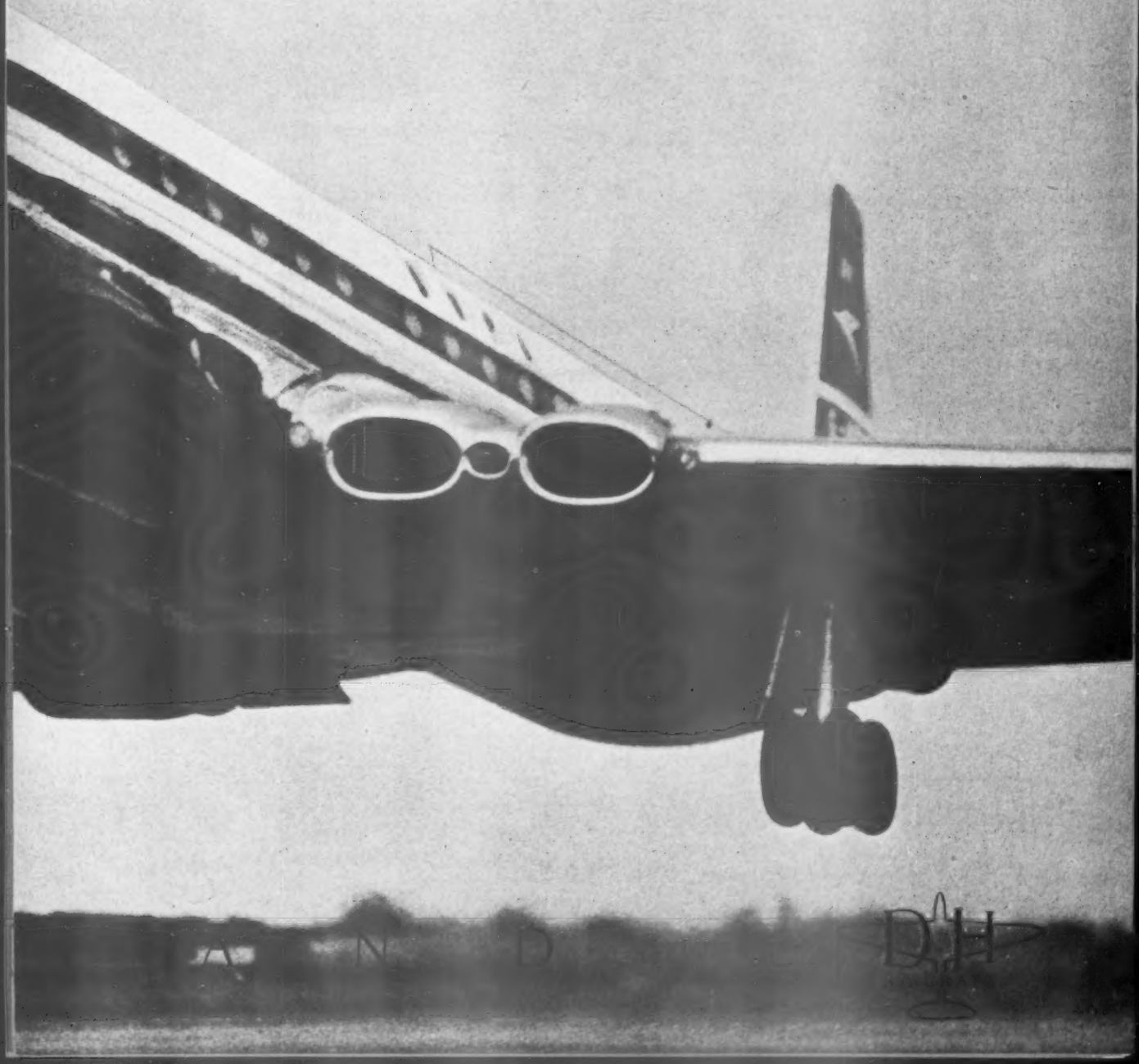

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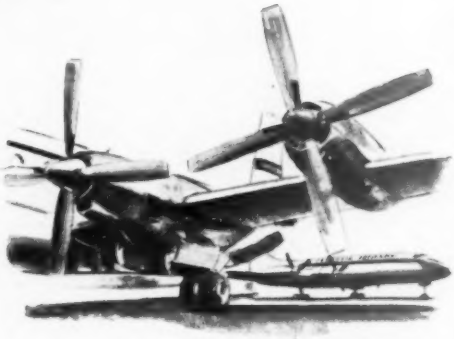

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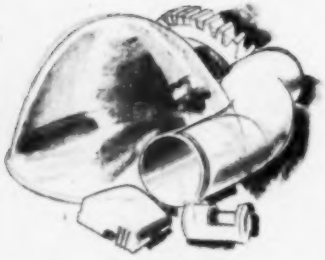

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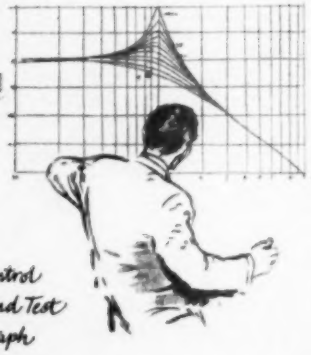

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Correspondence

"Great" Britain

TO judge from his letter published on May 29 (p. 633) Mr. Woods-Hill believes, as many others do, that the "Great" in "Great Britain" refers to military prowess or to other outstanding qualities of the country's inhabitants.

This is not so. "Great Britain" is simply a convenient geographical term for the combined areas of England, Scotland and Wales; hence the expression: "The United Kingdom of Great Britain and Northern Ireland." To pretend that the "Great" means anything else is to imply that Northern Ireland has contributed nothing to Britain's greatness.

Whipsnade, Beds. A. E. SLATER.

Comparisons are Odious

IT isn't fair to claim that the Arch to Arc race beat the Hare and Tortoise by only 10 minutes. You should compare the 1948 time with the fastest choppers from Chelsea Bridge to Issy or with Brian Neely's Charing Cross. For in 1948 special dispensation was granted for choppers to land in city centres both ends. This time about six minutes at each end must be subtracted which brings the time down to about 28 minutes, 20 minutes better than 1948. And the race proved the air journey was safe and the ground parts highly dangerous.

London, S.W.5. GEOFFREY DORMAN.

[Humph! "Hare and Tortoise" was designed to show what aeroplanes and helicopters could do if untramelled by surface transport. And this, we reckon, is just what it did.—ED.]

No. 18 Bomber Squadron

NO. 18 Squadron desires to collect photographs, souvenirs, and items of interest connected with the Squadron throughout its history, and would be obliged if any ex-members could send them to: Officer Commanding, No. 18 Squadron, Royal Air Force, Finningley, Doncaster, Yorks.

Finningley. G. E. W. EVANS,
Flight Lieutenant,
(for Officer Commanding, No. 18 Squadron).

Prenez Garde!

I WOULD like to suggest that caution be exercised in giving encouragement, financial or otherwise, to aircraft "off the drawing board." This expedient may well have been inevitable in wartime, having regard to the special demands of hostilities.

It is far less justified today and has led to grave calls upon the nation's purse in the past, although these have not always received the same publicity as is accorded to those occasions on which such a policy has received a measure of success.

We should surely wait until an airliner has flown and proved itself in the air, or at least gained definite airline support as in the case of the de Havilland 121, before the Minister of Supply rushes gallantly to its aid.

Brockenhurst, Hants. E. G. SUTHERLAND.

Sandringham VII, VH-APG

THANK you very much for "Pacific Cruisebird" by that grand Australian pioneer and veteran pilot, Capt. Sir Gordon Taylor (April 3, pp. 410-411). How delightfully refreshing it was to read this fine article on a grand old Short Sandringham VII, and how gratifying it was to learn that this boat is still going strong in her uniquely colourful career (as F-OBIP on T.A.I.'s Bora Bora/Tahiti schedules).

The distinguished author of your article will no doubt be pleased to hear that "Frigate Bird III's" two sister boats, the former B.O.A.C. "Bermuda"-class Sandringham VIIs, G-AKCP and G-AKCR, are still going strong as well! They were sold to C.A.U.S.A. of Uruguay back in 1955 and after considerable passenger cabin modifications, including fitting them with 45 seats and full air-conditioning plant, were placed on the Colonia/Buenos Aires and Montevideo/B.A. daily schedules.

Altogether a total of five Sandringhams are currently owned by C.A.U.S.A. whilst Aerolineas Argentinas (only 18 months ago) owned as many as seven modified Sandringhams, several of which continue to operate on a "pool basis" with C.A.U.S.A.'s high-density (and high-frequency too) schedules as listed above.

Tables Nos. 2084 and 2088 of the current monthly edition of *ABC World Airways Guide* clearly show the fine job-of-work these few remaining examples of the much-loved Short flying-boats are continuing to do in the vast and rich South American Continent. The British-designed and British-built flying-boat is by no means as "dead" as a lot of folks in the U.K. and elsewhere generally believe!

For the benefit of your flying-boat enthusiasts here are the registrations of both the Uruguayan and Argentine Short boats still going strong*. C.A.U.S.A.—CX-AFA, CX-AKF, CX-AKR, CX-ANA and CX-ANI. A.A.—LV-AAO, LV-AAR, LV-AAQ, LV-ACT, LV-AHH and LV-AHG.

Nairobi, Kenya. DENNIS M. POWELL.

(* Up to the end of 1957 so far as the earliest registrations are concerned.)

[In conclusion, I hope your distinguished author will forgive me if I correct him by stating G-AKCO's original B.O.A.C. name was "St. George" and not "Bermuda" which was actually the Class-name of these three Sandringham VIIs built for, but never flown on, B.O.A.C.'s schedules.]

Groundabout

Sailor on a Horse. The Cartoonist's Union has awarded its Diploma to Lieut. Stewart, R.N., for Demonstrating that Cartoons Can Actually Happen. Lieut. W. H. Stewart was Observer in a Sea Vixen during tropical trials in the African desert, when one intake intook a king-size vulture, starting a fire. He and the pilot ejected safely (thanks to the M. and B. treatment) at low height and high speed. Having survived this tight situation, he accepted a lift on a tribesman's horse, unwisely waved back to friendly villagers, fell off the horse and strained his back.

*

The Noise and the Place. An intriguing feature of the Show is the strange noises that come from the outdoor exhibition. A new one will be a rotor-motor demonstration so excruciating that its activities will be limited to four-second bursts, with intervals to allow spectators to get their ear-drums re-lined. These brief noises are not always easy to locate. It took one dim type—me, actually—three days to find out that those occasional explosions were coming from the Martin-Baker ejector-seat tower.

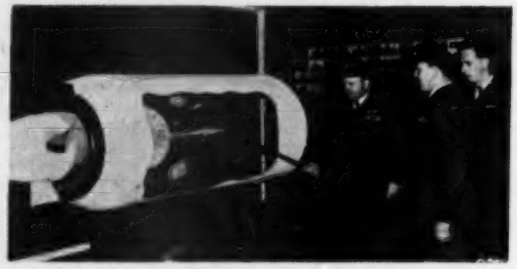
*

Scintillating Scimitars. At the S.B.A.C. Display, 807 Sqn. aim to show that the Navy is ship-shape on the ground as well as on the sea and in the air. They are going to land their Scimitars in opposite directions, folding their wings the while. The S.B.A.C. Flying Committee, I understand, turned down the Squadron's climactic idea of disappearing in formation down a flight-deck-type lift to be sunk in Runway 25 right in front of the President's enclosure. "If you want to disappear dramatically," said the Committee, "try flying in ever-decreasing circles."

"Skipper, are you sure their lordships know about this?"

by Gren

NOTES AND EVENTS



C.F.S. MODEL.—At the request of the R.A.F. Central Flying School, Henry Wiggin and Co., Ltd., recently presented its Dart animated model for instructional use in the Airmanship Hall at Little Rissington. The Commandant, Air Cdre. J.N.H. Whitworth, Sqn. Ldr. R. S. Eyre, and Flt. Lt. J. Aitken are seen looking at the model.

IMPROVED DINGHY.—In conjunction with M.o.S. and the Institute of Aviation Medicine, Farnborough, Elliot Equipment, Ltd., has developed and manufactured an addition to its range of dinghies. This is the M.S. 20 Mk. 2 aircraft dinghy which incorporates an inflatable boarding platform and full insulation of the floor, hull and weather covers.

RADAR ORDERS.—Decca weather radar is being installed at Geneva (Cointrin) and Zurich (Kloten) Airports. The new Decca D.A.S.R.1 S-band air surveillance radar has been ordered for Malmo Airport, in addition to Stockholm and Gothenburg, and will also be installed at Maiqueta Airport, Caracas.

NEW OXYGEN SERVICE.—The British Oxygen Group announced on August 4 that all its specialized services to aviation are being co-ordinated through a new organization, British Oxygen Aviation Services. The units of the Group involved are British Oxygen Gases, British Oxygen Engineering, British Oxygen Aro Equipment and British Oxygen Research and Development. It will operate from the Group Head Office, at Bridgewater House, St. James's, S.W.1. Mr. J. R. T. Bradford, who recently joined British Oxygen Aro Equipment as Sales Manager, will manage the new organization.

CHANGE OF ADDRESS.—The head office of the British Air Line Pilots Association has moved to 81 New Road, Harlington, Middlesex. Telephone: Hayes 3442-3. Telegrams and cables: Aeropilot, Hayes, Middlesex.

A.W.A. NAME CHANGE.—The new division of Sir W. G. Armstrong Whitworth Aircraft, Ltd., formed when A.W.A. took over the Technical Developments Division of the Gloster Aircraft Co., in June, will in future be known as Armstrong Whitworth Equipment. A.W.E. will manufacture and market a variety of hydraulic and fuel system equipment and advanced electronic equipment from A.W.A.'s commercial electronic department.

Company Notices

New Patents

APPLICATIONS ACCEPTED

819,665.—National Research Development Corporation.—" High-speed aircraft."—July 19, 1957. (Aug. 13, 1956.)

819,919.—Bouffort, V. A.—" Aircraft provided with elevated stabilizing members."—May 16, 1956. (May 27, 1955.)

819,696.—Switlik Parachute Co., Inc.—" Quick release mechanism for parachute containers."—Oct. 11, 1957. (Nov. 19, 1956.)

Printed specifications of above available Sept. 9, 1959. Opposition period expires Dec. 9, 1959.

820,062.—Boeing Airplane Co.—" Airflow directional indicator."—April 9, 1957.

820,124.—Zborowski, H. P. G. A. R. von.—" Structures, particularly aircraft components."—June 5, 1956. (June 8, 1955.)

820,009.—Minister of Supply.—" Aircraft capable of flight at supersonic speeds."—Mar. 22, 1957. (Apr. 3, 1956.)

820,337.—Bathurst, G. B.—" Gas turbines."—Apr. 10, 1956. (Jan. 11, 1955.)

820,376.—All American Engineering Co.—" Jet engine power plant particularly for use in launching aircraft."—July 2, 1956.

820,061.—Boeing Airplane Co.—" Wind-tunnel model support."—Apr. 9, 1957.

820,591.—National Research Council.—" Icing detector."—May 15, 1957. (May 24, 1956.)

820,592.—National Research Council.—" Whirling icing detector."—May 15, 1957. (May 24, 1956.)

820,418.—D. Napier and Son, Ltd., and Rotol, Ltd.—" Control systems for aircraft engines." Nov. 1, 1957. (Nov. 13, 1956.)

820,721.—Douglas, A.—" Control of aircraft by fluid jet reaction."—Sept. 26, 1955. (Oct. 2, 1954.)

820,427.—Soc. Nationale d'Etude et de Construction de Moteurs d'Aviation.—" Device for the regulation of the jet of a jet propulsion unit."—June 21, 1957. (July 3, 1956.)

820,771.—United Aircraft Corporation.—" Thrust reversal mechanism for use with a jet exhaust gas-discharge duct."—Nov. 12, 1957. (Nov. 21, 1956.)

Printed specifications of above available Sept. 23, 1959. Opposition period expires Dec. 23, 1959.

Personal Notices

BIRTHS

Edmonds.—On August 22, at Malmesbury Hospital, to Anne (*née* Clarke), wife of Flt. Lt. V. T. Edmonds, R.A.F.—a son (Victor Miles).

Elias.—On August 13, at R.A.F. Hospital, Changi, Singapore, to Joyce, wife of Flt. Lt. J. Elias, R.A.F.—a son (Arnold Walker).

Harvey.—On August 9, at Harrogate General Hospital, to Patricia (*née* Donegan), wife of Flt. Lt. J. J. Harvey, R.A.F.—a daughter.

Holmes.—On August 6, to Josephine (*née* Hunter), wife of The Rev. Finlay Holmes, of R.A.F., Jever, Germany—a son (Patrick).

Hosea.—On August 20, at Rochford Hospital, Essex, to Anne (*née* Williams), wife of Flt. Lt. Peter Hosea, R.A.F.—a daughter (Joanne Susan).

Jarrett.—On August 14, at Glebe Cottage, Guilsborough, Northants, to Mary (*née* Tompkins), wife of Flg. Off. Frank Jarrett, R.A.F.—a son.

Millen.—On August 5, at B.M.H. Dhekelia, Cyprus, to Nellie (*née* Gibbs), wife of Flt. Lt. M. S. Millen, R.A.F.—twin daughters.

Probert.—On August 17, at B.M.H. Bristol, to Hilary (*née* Plowman), wife of Flt. Lt. Raymound Probert—a son (Timothy Blair).

Robinson.—On August 15, at Radcliffe Infirmary, Oxford, to Joan Elizabeth (*née* Dauncey), wife of Flt. Lt. D. C. Robinson, R.A.F.—a daughter.

Richardson.—On August 15, at Princess Mary's Hospital, Halton, to Betty (*née* Wilson), wife of Flt. Lt. N. J. Richardson—a son (James).

Stanning.—On August 14, at R.A.F. Hospital Ely, to Averil (*née* Daniel), wife of Flt. Lt. Peter Stanning, R.A.F.—a daughter.

Swain.—On August 17, at P.M.R.A.F. Hospital, Halton, to Carol (*née* Beauchamp), wife of Flt. Lt. C. de P. D. Swain, R.A.F.—a son.

Wilkinson.—On August 16, at Rutland Memorial Hospital, to Marjorie, wife of Flt. Lt. John Wilkinson, R.A.F.—a son (Adrian).

DEATH

Beatty.—On August 17, at 11 Kenilworth Road, Fleet, Hants, Capt. Marcus Alfred Beatty, B.O.A.C.

Aviation Calendar

September 4.—R.Ae.S. Symposium, " Operational Problems of Take-off and Landing," by L. P. Coombes, E. W. Pike, Captain B. O. Prowse and E. S. Calvert at the Library, 4 Hamilton Place, **London**, W.1, at 19.00 hrs.

September 4.—I.A.F. Space-law Colloquium at Great Hall, Lincoln's Inn, **London**, W.C.1.

September 5-6.—B.W.P.A. Flying Meeting, **Sywell**, Northants.

September 7-13.—S.B.A.C. Display and Exhibition at **Farnborough**.

September 10.—The Helicopter Association of Gt. Britain Annual Dinner, Dorchester Hotel, Park Lane, **London**, W.1.

September 10.—University of London extra-mural studies lecture, " Atmospheric Energy Radiation," by Dr. R. S. Scorer, M.A., Ph.D., at the Kronfeld Club, Basement, 74 Eccleston Square, **London**, S.W.1.

September 11-13.—Rally at **Baden Baden** organized by the German Aero Club.

September 13.—Newcastle upon Tyne Aero Club " At Home " and air race, **Woolsington.**

September 14.—Brancker Memorial Lecture, " World Peace Through Air Transportation," by Capt. E. V. Rickenbacker (Eastern Airlines) at the Royal Inst. of British Architects, 66 Portland Place, **London**, W.1, at 17.45 hrs.

September 14-20.—Battle of Britain Week.

September 15-18.—International Agricultural Aviation Conference at College of Aeronautics, **Cranfield**, Beds.

September 19.—International balloon competition at **Zürich.**

September 19.—R.A.F. " At Home " Day.

September 19.—Aviation Forum's Airborne dinner. Rendezvous at **Blackbushe Airport** 18.15 hrs.: take-off 19.00 hrs. 42s. per head. Book, John Elliott, Hon. Treasurer, Aviation Forum, 14 Tudor Court, Gunnersbury Ave., W.5.

September 20.—Battle of Britain Sunday.

September 23.—R.Ae.S. Graduates' and Students' Section film show, at the Library, 4 Hamilton Place, **London**, W.1, at 19.30 hrs..

September 24.—University of London extra-mural studies lecture, " Weather Charts, Fronts," by C. E. Wallington, M.Sc., at the Kronfeld Club, Basement, 74 Eccleston Square, **London**, S.W.1.

September 24-25.—Aerodrome Owners Association conference, Royal Hotel, **Bristol.**

September 26-27.—Rally organized by the Genoa Aero Club, **Italy.**

September 29.—R.Ae.S. Luton Branch lecture, " Ballistic Missile Design," by E. C. Cornford (joint lecture with E.E.C.), at English Electric, **Stevenage**, at 18.30 hrs.

NEW COMPANIES

Clanair, Ltd. (629,957).—Private co. Reg. June 9. Cap. £100 in £1 shs. Air transport co., etc. Subscribers (each with one sh.): E. A. Blackmore and S. R. Ward, both of 18 Austin Friars, E.C.2. First directors are not named. Sols.: Slaughter and May, 18 Austin Friars, E.C.2.

Flightways, Ltd. (632,936).—Private co. Reg. July 17. Cap. £100 in £1 shs. Objects: To promote, arrange and conduct holiday and other trips, tours, etc. Subscribers (each with one sh.): Romany Van Bosche, 21 Wallace Court, Marylebone Road, N.W.1, shorthand typist, and Mrs. Sonia Peill Clark, 37 Selwyn Crescent, Welling, Kent. First directors to be appointed by subscribers. Sols.: Friedman Fredman and Co., S.W.1. Reg. Off.: Panton House, Haymarket, S.W.1.

Flying Farmers, Ltd. (632,998).—Private co. Reg. July 17. Cap. £1,000 in £1 shs. Crop spraying constructors, etc. Directors: Cecile M. Hemans, 26 St. Annes Terrace, N.W.8, David H. Woolley, Orchard Hill, Liss, Hants, and Charles E. C. Woolley, Barton Park Farm, Petworth, Sussex. Sec.: Cecile M. Hemans. Sols.: Malcolm Slowe and Co., W.1. Reg. Off.: 78 Old Broad Street, E.C.2.

Harlohire, Ltd. (633,061).—Private co. Reg. July 20. Cap. £1,000 in £1 shs. Carriers of passengers and freight by air, land and sea, etc. Directors: James B. Plunkett and Mrs. Phyllis D. Plunkett, both of 128 Pennymead, Harlow, Essex. Sec.: Phyllis D. Plunkett. Sols.: Trotter, Chapman and Whisker, Epping, Essex. Reg. Off.: 169 High Street, Epping, Essex.

CHANGE OF NAME

Clanair, Ltd. (497,053).—Air Transport Contractors, etc., 2 St. Mary Axe, E.C.4. Name changed to British and Commonwealth Shipping Company (Aviation), Ltd., on March 13, 1959.

The History of E.A.T.O.35

this Oil set engine designers free!

To forward their plans of producing increased thrust from aviation gas turbines of comparable size or even reduced frontal area—engine builders needed new metals, new alloys, new designs . . . and a new oil.

ESSO AVIATION TURBO OIL 35 was introduced nearly 10 years ago. It is still the only approved lubricant on which all British turbojet and turboprop engines can develop and sustain full design performance wherever they fly.

PERFORMANCE:
E.A.T.O.35 is the only lubricant that fulfils every requirement in all turboprop and turbojet engines under all operational conditions in all British aircraft. Essential properties are maintained throughout its life, and E.A.T.O.35 is fully capable of withstanding maximum design temperatures.

ECONOMY:
E.A.T.O.35 has the lowest operational cost of all engine oils in airline use. It has solved the problems attending the storage of several oil grades, and has eliminated many other organisational problems in airline operation. It has extraordinary life in civil operation because it suffers little degradation in normal use. Repeated reclamation by filtering of used E.A.T.O.35—carried out by approved specialist firms—still further increases the economy of its employment.

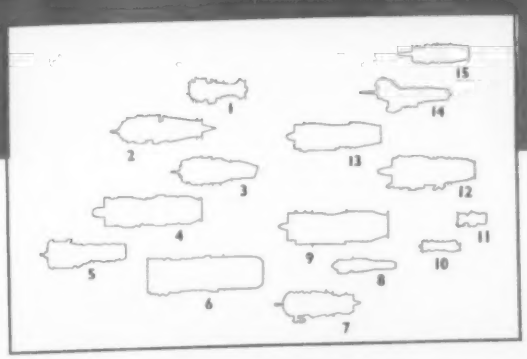
AVAILABILITY:
Stocks of E.A.T.O.35 are maintained at all the major airports used by operators of turbine-engined aircraft.
This oil has been a consistent earner of foreign currency for Great Britain over a number of years, and it has been a factor in the sale of British aero engines oversea.

Esso

pre-eminent in lubrication

Every famous engine illustrated here was developed on, and ran its type-acceptance trials on E.A.T.O.35

1 Napier Gazelle (1800 S.H.P.)
2 Napier Eland (3500 E.H.P.)
3 Rolls-Royce Dart (2105 E.H.P.)
4 Rolls-Royce Avon (10,500 lb. thr.)
5 Rolls-Royce Tyne (5525 E.H.P.)
6 Rolls-Royce Conway (16,500 lb. thr.)
7 Bristol Siddeley Proteus (4445 E.H.P.)
8 Bristol Siddeley Orpheus (5000 lb. thr.)
9 Bristol Siddeley Olympus (17,000 lb. thr.)
10 Blackburn Turmo (450 S.H.P.)



1. Blackburn Palouste (252 E.H.P.)
2. de Havilland Gyron Junior (7000 lb. thr.)
3. Bristol Siddeley Sapphire (11,000 lb. thr.)
4. Bristol Siddeley Double Mamba (3873 E.H.P.)
5. Bristol Siddeley Viper (2460 lb. thr.)

The History of E.A.T.O.35

this Oil set

engine designers free!

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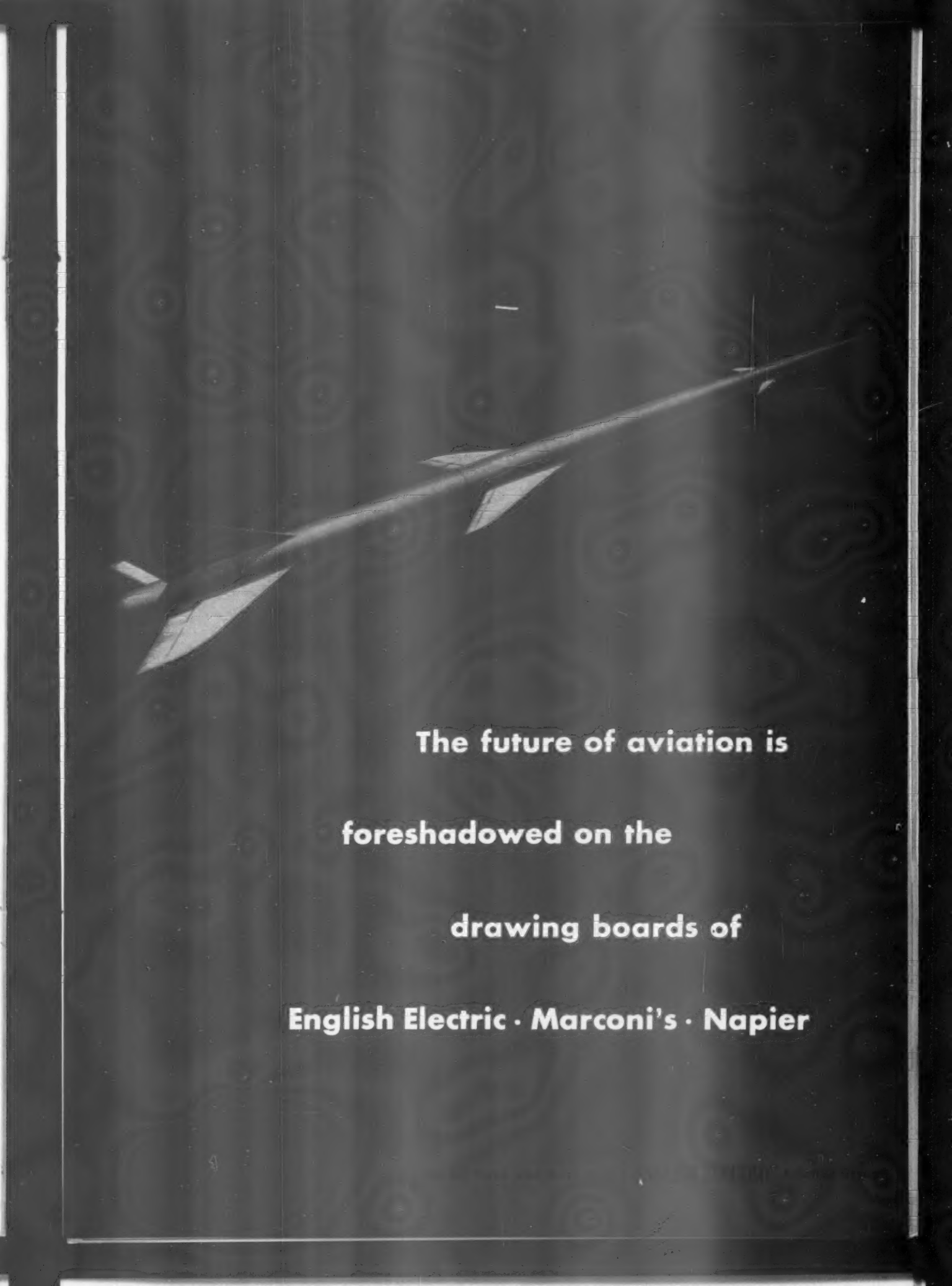
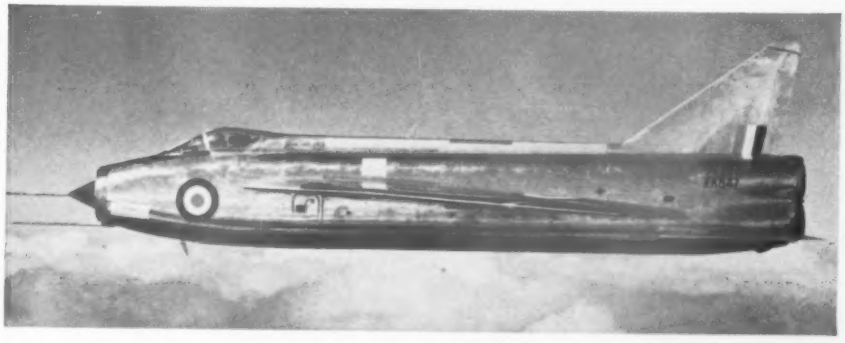

The future of aviation is
foreshadowed on the
drawing boards of
English Electric · Marconi's · Napier

LIGHTNING

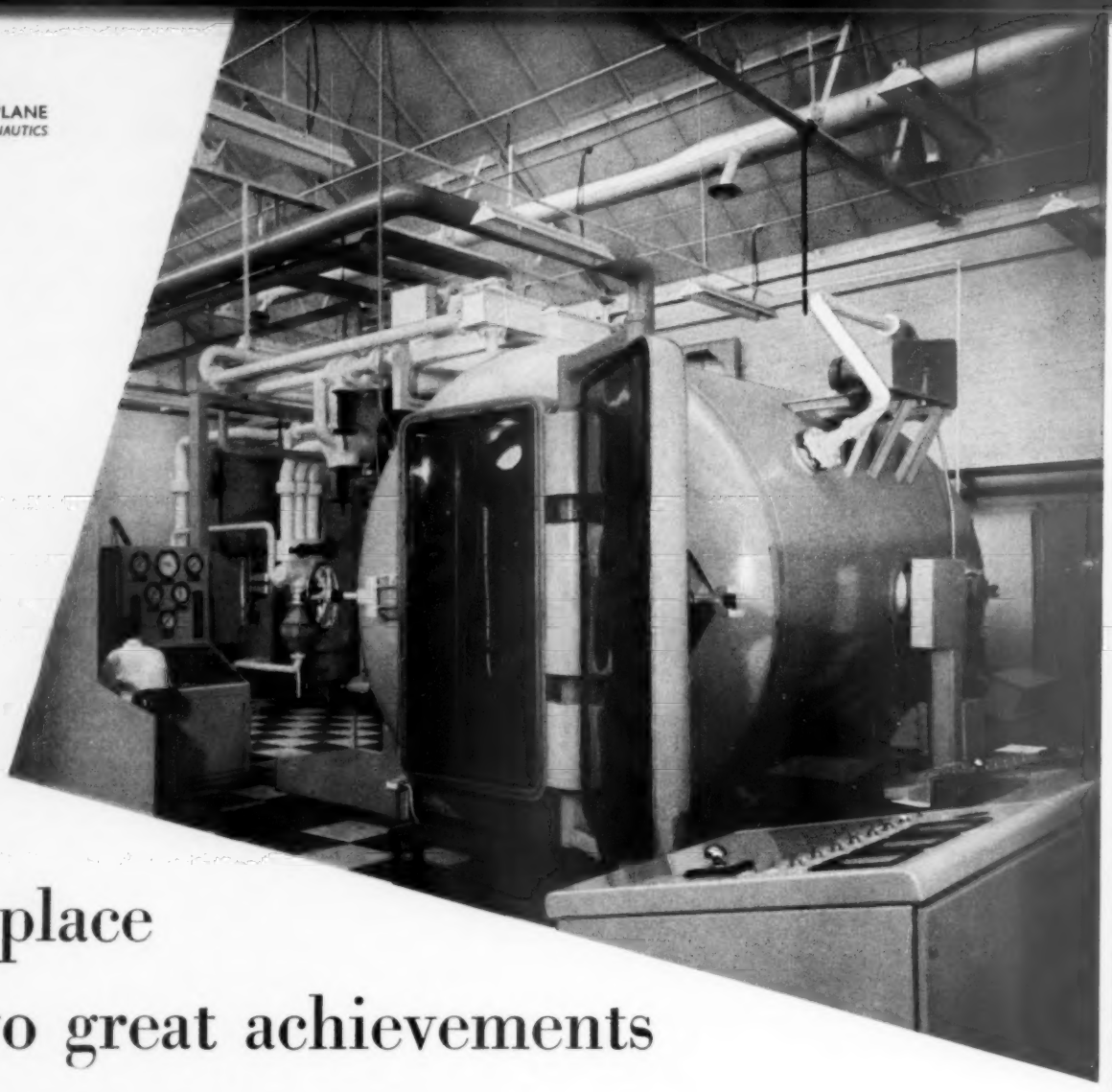
The Lightning can operate by day or night in all weathers. It has full navigational aids, airborne search and track radar.
The Lightning has been designed as an integrated weapons system so that its armament, fire control system and other equipment work together as a co-ordinated whole.
The Lightning is capable of speeds greater than Mach 2 in level flight yet its low speed flying characteristics are exceptional.
The Lightning is inherently aerodynamically stable and free from pitch up throughout its speed range without assistance from electronic aids.
The Lightning has twin engines which give duplication of all power systems. Twin engines also give the aircraft supersonic performance without reheat and the positioning of the engines along the centreline of the fuselage provides maximum safety since the aircraft does not develop asymmetric characteristics when flying on one engine.



THE INCOMPARABLE *LIGHTNING*

ENGLISH ELECTRIC AVIATION LIMITED · MARCONI HOUSE · STRAND · LONDON · WC2

A MEMBER OF THE ENGLISH ELECTRIC AVIATION GROUP



Birthplace of two great achievements

This is a part of the great Research Laboratory set up by English Electric's Aircraft Equipment Division in Bradford.

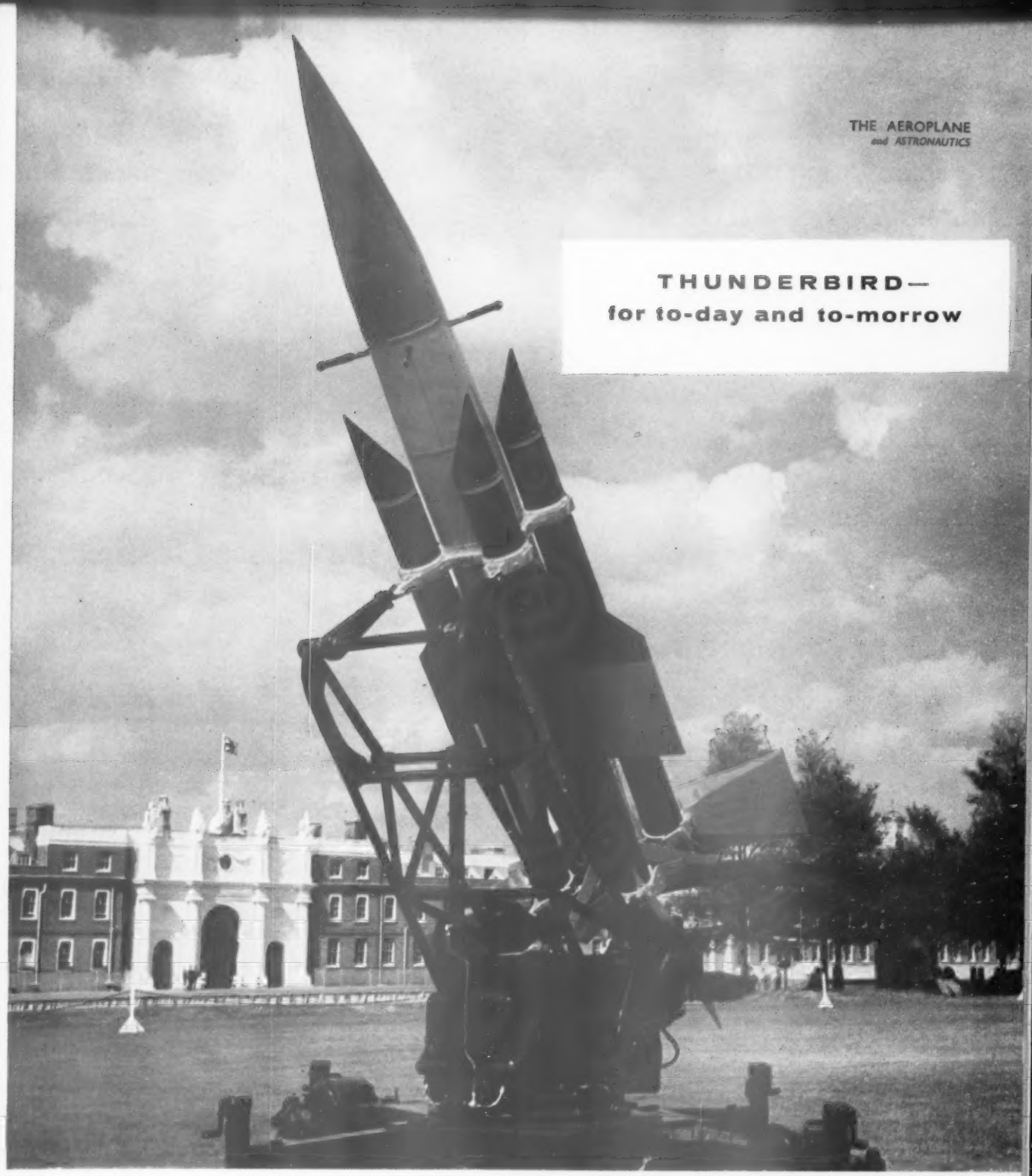
This Laboratory forms part of the facilities which assisted in the development of the first Brushless A.C. Generator to come out of Britain and Europe—a major step forward. Now, from this same source, comes its D.C. system counterpart—the Brushless D.C. Generator. This Generator—forerunner of a new family of equipment—is on show for the first time on Stand 282/283 at Farnborough.

'ENGLISH ELECTRIC'
aircraft equipment

THE ENGLISH ELECTRIC COMPANY LIMITED, AIRCRAFT EQUIPMENT DIVISION
PHOENIX WORKS, BRADFORD, ENGLAND

A MEMBER OF THE ***ENGLISH ELECTRIC*** *AVIATION GROUP*

G.W.43



THUNDERBIRD—
for to-day and to-morrow

The English Electric Thunderbird exists today as a fully developed weapon of defence; it has undergone service trials and is in production. It is in service with the Army. The successor of Thunderbird is well under way. Employing advanced techniques, it will have increased range, increased low level capability, even greater reliability and be fully mobile and air transportable.

'ENGLISH ELECTRIC' THUNDERBIRD

ENGLISH ELECTRIC AVIATION LIMITED

Guided Weapons Division

LUTON · STEVENAGE · WOOMERA

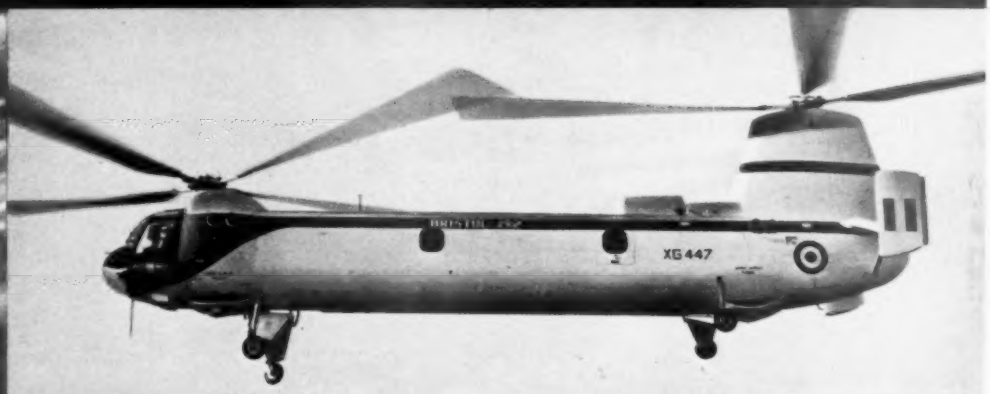
A MEMBER OF THE ENGLISH ELECTRIC AVIATION GROUP

THE AEROPLANE
and ASTRONAUTICS

NAPIER'S PLACE IN THE SKY

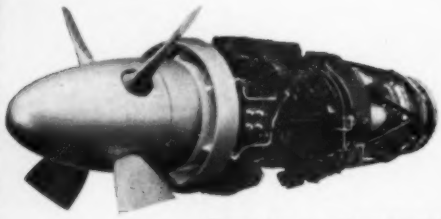
POWER

Two Napier Gazelles



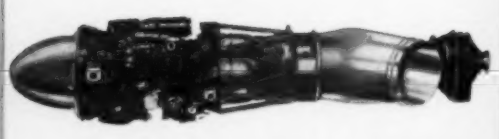
ACHIEVEMENT

Crane



Eland for the Canadair 540.

Also at Farnborough we shall be showing you a selection of precision castings made by the Napiercast method and, of course, Spraymat—the universally adopted thermo-electrical de-icing system.



Eland for the Westminster.

Eland for the Rotodyne.

Gazelle free turbine.

Napier leads in modern helicopter power at Farnborough this year with the Eland engines fitted to the Westland Westminster and the record-breaking Fairy Rotodyne, and with the free turbine Gazelles powering the Westland Wessex and Bristol 192.

SEE THEM AND OTHER NAPIER ACHIEVEMENTS ON STANDS N AND 113

D. NAPIER & SON LTD. LONDON, W.3. MEMBER OF THE ENGLISH ELECTRIC AVIATION GROUP

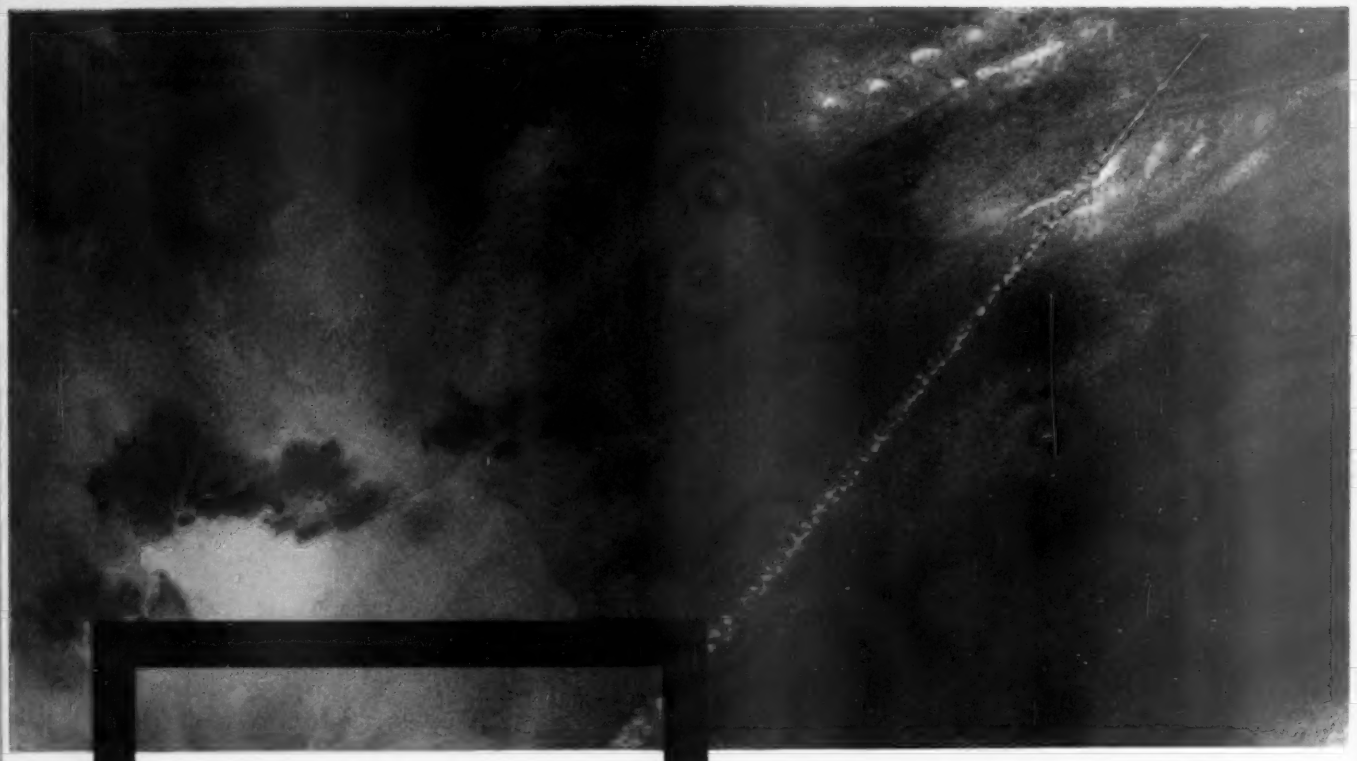
IN ACHIEVEMENT

Fairy Rotodyne—Two Napier Elands.

IN POWER

Wessex—Napier Gazelle.

And overseas, Napier leads in a new deal for Airline operators with the Eland Jet-Props in the Canadair/Convair 540. A demonstration aircraft is being shown to operators all over the World.



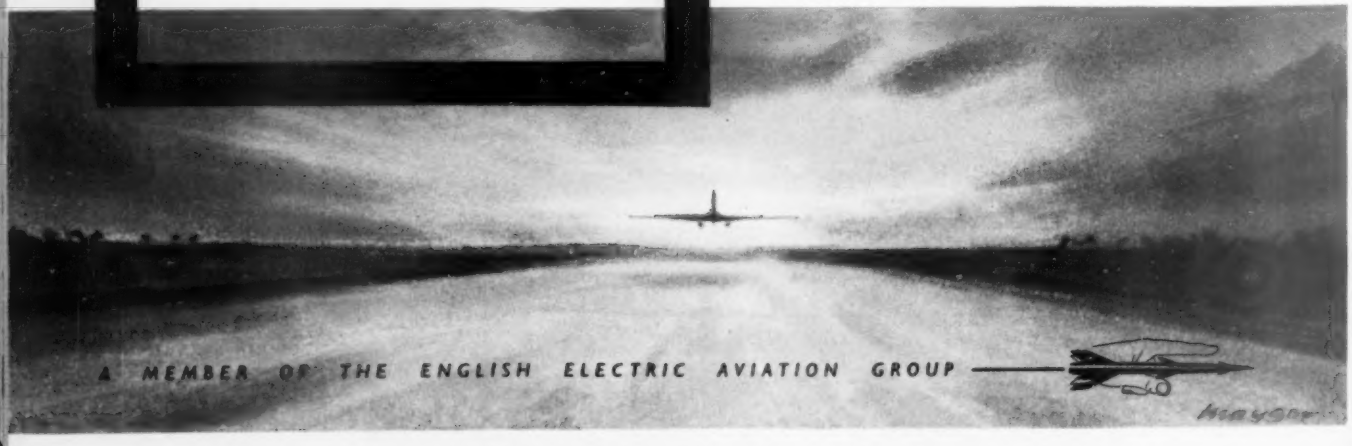
MARCONI in electronics for Aviation

More than fifty Civil Airlines and thirty Air Forces use Marconi radio, radar and navigational aids.

MARCONI

Airport and Aircraft Systems for Communications and Navigational Aids

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX.



A MEMBER OF THE ENGLISH ELECTRIC AVIATION GROUP

Twentieth S.B.A.C. Display

What to see at Farnborough

Featuring more guided weapons and ancillary equipment than ever before, the 20th Flying Display and Exhibition to be staged by the Society of British Aircraft Constructors opens at Farnborough on Tuesday, September 8—with a record number of exhibitors—376.

The area covered by the exhibition building, which was rebuilt in 1957, will be the same, approximately 125,000 sq. ft. But the outside equipment display has been increased in area by 50%, and the guided weapons park has had to be enlarged by some 40%. These increases to the combined areas of these two outside displays amount to no less than 60% of the area of the main exhibition building.

The pattern of the display is to be similar to that in previous years with Monday restricted for the Press and technicians' pre-view; the formal guest days on Tuesday, Wednesday and Thursday; and Friday, Saturday and Sunday reserved for the public.

In addition to manufacturers' aircraft, R.A.F. and Fleet Air Arm teams are taking part in the flying display. The R.A.F. programme includes a Transport Command fly-past, two Jet Provosts from C.F.S., a combined formation comprising three Victors, three Vulcans and six Javelins, and No. 111 Squadron. The Fleet Air Arm display will consist of a Scimitar aerobatic team from No. 807 Squadron.

On the following 51 pages will be found a review of the products of the industry and a preview of the current aircraft, engines, missile and ancillary exhibits to be seen at Farnborough, together with a special feature on new aircraft and other equipment.

On the next 15 pages will be found a guide to the exhibits on the stands. The 376 exhibitors are listed alphabetically with their stand numbers; the initials O.D.S. indicate the outside display sites, and R.D.S. the radar demonstration sites.

A directory on non-exhibitors is given at the back of the issue.

Major Exhibits

AIRCRAFT

Armstrong Whitworth Argosy; Auster Aiglet Trainer; Avro Vulcan B.2; Blackburn N.A.39; Bristol Britannia 253; Bristol Type 192 helicopter; de Havilland Comet 4B; de Havilland Beaver Series 2; de Havilland Sea Vixen FAW.1; de Havilland Heron 2; de Havilland Dove; de Havilland Vampire Trainer; English Electric P.1B Lightning; English Electric Lightning Trainer; English Electric Canberra PR.9; Fairey Rotodyne; Fairey Gannet AEW.3; Folland Gnat; Folland Gnat Trainer; Gloster Javelin FAW.9; Handley Page Victor B.2; Handley Page Dart Herald; Hawker Hunter FGA.9 and 66A; Hunting Jet Provost 2, 3 and 51; Hunting President; Saro P.531 helicopter; Saro Skeeter helicopter; Scottish Aviation Twin Pioneer; Vickers Vanguard; Vickers Viscount 816; Westland Westminster; Westland Wessex; Westland Whirlwind; Westland Widgeon; Rolls-Royce Conway-Vulcan. The S.R.N.1 Hovercraft is to be demonstrated.

GUIDED WEAPONS

Armstrong Whitworth Seaslug; Bristol Bloodhound; English Electric Thunderbird; Fairey anti-tank weapon; Jindivik; Pye anti-tank weapon; Saro Black Knight research vehicle; Short Seacat; Vickers anti-tank missile.

POWERPLANTS

Alvis Leonides Major 755/1; Alvis 530 long-stroke Leonides; Alvis Leonides 554/1; Blackburn A.129; Blackburn Turmo 600; Blackburn Palas; Bristol Siddeley Olympus; Bristol Siddeley BE.58 ducted fan; Bristol Siddeley Orpheus BOr.12; Bristol Siddeley Olympus; Bristol Siddeley Viper ASV.11; Bristol Siddeley Proteus 765; Bristol Siddeley Thor BT-1; Bristol Siddeley Gamma and PR-23 rocket engine; de Havilland Gnome; de Havilland Gyron Junior; de Havilland Gipsy Major; de Havilland Double Spectre; Napier Eland; Napier Gazelle; Napier Scorpion, Double Scorpion and Triple Scorpion rocket engines; Rolls-Royce Conway RCo.10; Rolls-Royce Avon RB.146; Rolls-Royce Avon RA.29; Rolls-Royce RB.108; Rolls-Royce RB.145; Rolls-Royce Tyne turboprop.

Guide to the Static Displays . . . .

Accles and Pollock, Ltd. (111). A range of standard high-tensile aircraft bolts, also aircraft metal thread screws. The company is also showing the tools and method of manufacture for a cold-headed high-tensile bolt.

Acton Bolt, Ltd. (112). Manufacturers of cold-headed and thread-rolled aircraft bolts; steel and brass screws; nuts and steel turned parts.

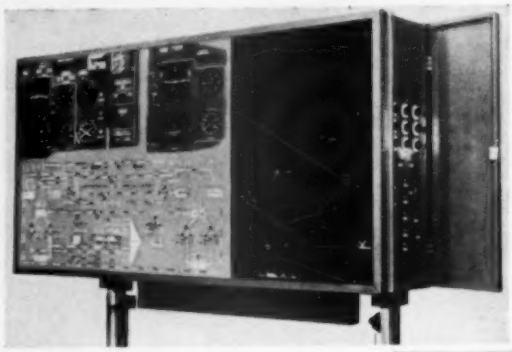
Aero Controls, Ltd. (134). Two types of AC-Flex flexible pipe couplings; a light-weight coupling for pipes; quick-release fasteners; cowling fasteners and screw-type fasteners; rudder bars; universal joints; combined wheel and jack units.

Aircraft Materials, Ltd. (248). Products include the Pop and Imex ranges of rivets; parachute, ejector-seat and helicopter rescue-harness fittings; supply-dropping equipment including de-reefing devices.

Airmed, Ltd. (95). A full range of head-set and oxygen mask equipment is being displayed including the Airlite headset and mask assembly, and the Simplite headset, which is being shown for the first time and is designed primarily for the private operator. For ground-control purposes the company has introduced a single telephone headset known as the Unilite. Miniaturized oxygen regulators will also be shown.

The Airscrew Co. and Jicwood, Ltd. (155). A wide range of axial-flow and centrifugal fans for cabin ventilation, oil cooling, wind-screen demisting and de-icing and radio cooling on civil and service aircraft are featured. The centre-piece of the stand is a working model of a Dragonair heater fan and a scale model of the fan unit which supplies the lifting and propelling force for the Saunders-Roe Hovercraft.

Airtech, Ltd. (O.D.S.T.). Exhibits include the Aircon type B container for transportation in Britannia 253; Tubelock polythene tube fittings; electronic equipment.



An Air Trainers' Link classroom training aid of the Bendix Flight System for the Boeing 707.

Air Trainers Link, Ltd. (212). An example of a fully animated classroom training aid in the form of the Bendix flight system fitted to B.O.A.C. Boeing 707s. Models of the Comet 4B flight simulator for B.E.A., four-station automatic radio-aid attachments and a computer for British Petroleum, Ltd.

Albright and Wilson, Ltd. (123). Producers of Kanigen plate, a chemical nickel-phosphorus plating process.

Alvis, Ltd. (1) A range of piston engines for aircraft and helicopters including the Leonides Major 755/1 of 795 b.h.p., the 530 Series Leonides (long-stroke) of 640 b.h.p. and the Leonides 554/1 of 635 b.h.p.

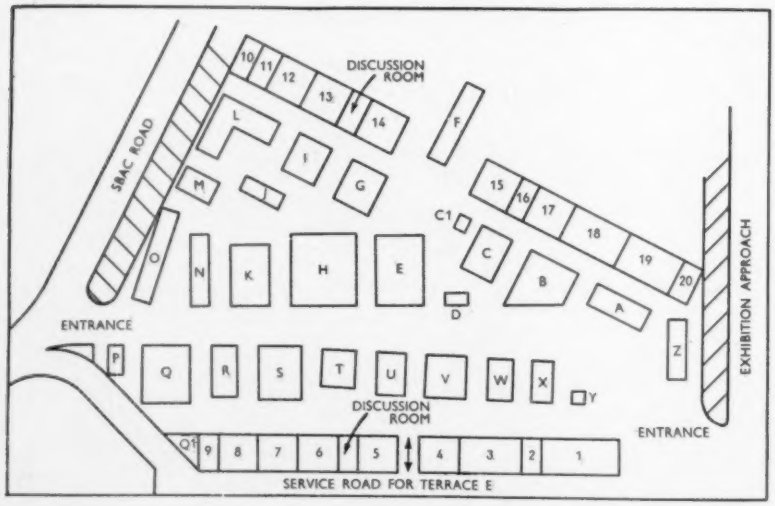
Amalgamated Wireless (Australia), Ltd. (13). See Marconi's Wireless Telegraph Co., Ltd.

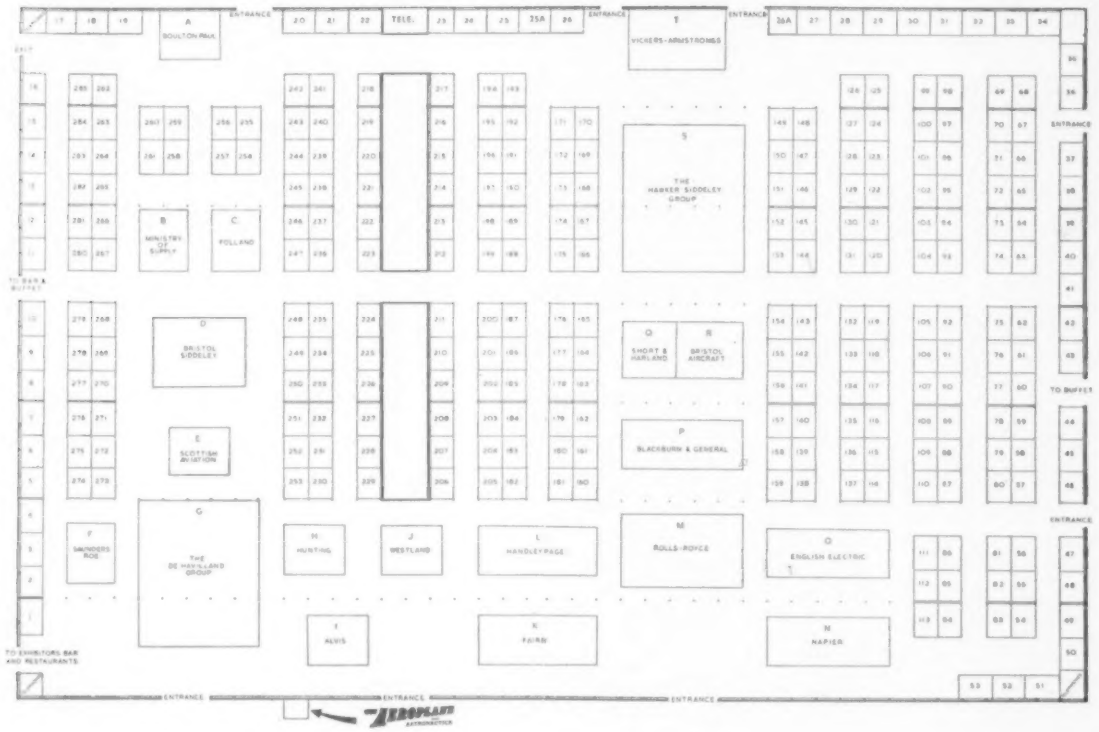
Amplivox, Ltd. (196). For the first time Amplivox is exhibiting its current range of headphones and headsets for aircrew and ground control use, including an ear defender headset and communication helmet developed in conjunction with R.A.E., Farnborough. Also on show is a complete transistorized communication system specially designed for the Spadeadam Rocket Site with special lightweight head-sets designed to fit under safety helmets.

The latest Amplivox communication head-set with ear defenders and noise-cancelling microphone issued recently to the R.A.F. for use on Transport Command Britannias and Beverleys.

OUTDOOR DISPLAY SITES

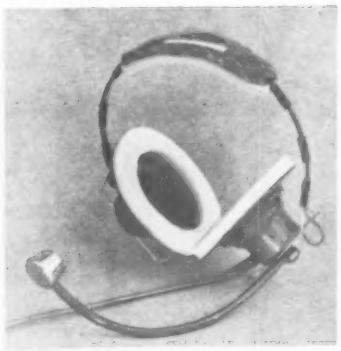
Company	*Stand No.*
Airtech, Ltd.	T
Auto Diesels, Ltd.	2 and W
Blackburn Engines, Ltd... ..	16 and C
British Oxygen Engineering, Ltd.	S
J. Brockhouse & Co., Ltd. ..	Q
Brown Brothers (Aircraft), Ltd.	5
David Brown Industries, Ltd. ..	D
A. C. Cossor, Ltd.	17
Delanay Gallay, Ltd.	8
Dexion, Ltd.	19 and A
H. W. Edghill & Co., Ltd. ..	10 and L
Ekco Electronics, Ltd.	R
Elliott Brothers (London), Ltd.	7
Esso Petroleum Co., Ltd. ..	O
Sir George Godfrey & Partners, Ltd.	6
H.M.L. (Engineering), Ltd. ..	1
Houchin, Ltd.	20 and Z
Kelvin & Hughes (Aviation), Ltd.	13
Laporte Chemicals, Ltd... ..	14 and G
Joseph Lucas (Gas Turbine Equipment), Ltd.	18 and B
Lucas-Rotax, Ltd.	
Rotax, Ltd.	
M.L. Aviation Co., Ltd... ..	K
Marconi Instruments, Ltd. ..	N
Martin-Baker Aircraft Co., Ltd.	F
Microcell, Ltd.	12
Ministry of Supply	3
Morfax, Ltd.	4 and V
Palmer Aero Products, Ltd. ..	X
Pye Telecommunications, Ltd...	9 and Q1
The Pyrene Co., Ltd.	P
Rellumit (London), Ltd. ..	M
Rover Gas Turbines, Ltd. ..	15 and C1
Saunders Valve Co., Ltd. ..	11
Short Brothers & Harland, Ltd.	E
Simmonds Aerocessories, Ltd...	U
Tecalemit, Ltd.	J
Thorn Electrical Industries, Ltd.	Y
Vernons Industries, Ltd... ..	I
Zwicky, Ltd.	H





Principal Exhibitors

Company	*Stand No.*	*Company*	*Stand No.*	*Company*	*Stand No.*
Alvis, Ltd.	I	The Fairey Aviation Co., Ltd. ..	K	Rolls-Royce, Ltd.	M
Blackburn & General Aircraft, Ltd.	P	Folland Aircraft, Ltd.	C	Saunders-Roe, Ltd.	F
Boulton Paul Aircraft Ltd. ..	A	Handley Page, Ltd.	L	Scottish Aviation, Ltd.	E
Bristol Aircraft, Ltd.	R	The Hawker Siddeley Group ..	S	Short Brothers & Harland, Ltd. ..	Q
Bristol Siddeley Engines, Ltd. ..	D	Hunting Aircraft, Ltd.	H	Vickers-Armstrongs (Aircraft), Ltd.	T
The de Havilland Enterprise ..	G	Ministry of Supply..	B	Westland Aircraft, Ltd.	J
The English Electric Co., Ltd. ..	O	D. Napier & Son, Ltd.	N		



On show is this Simplite headset which has been designed primarily for the private operator by Airmed.

Auster Aircraft, Ltd. (249). A variety of Auster types are featured, including the Workmaster and the Aiglet trainer.

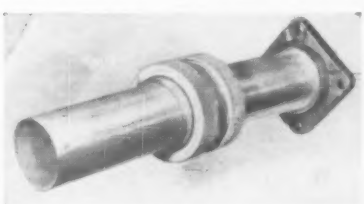
Auto Diesels, Ltd. (O.D.S. 2 and W). Products include petrol and diesel engine-driven generating sets, jet aircraft starters and aircraft ground-servicing units.

Automotive Products Co., Ltd. (44), and **Lockheed Precision Products, Ltd.** (45). Hydraulic equipment including new electrically signalled selector valve; relief valve and flow indicator. Purlator filters, self-sealing couplings, fuel filter/water separators.

Avery-Hardoll, Ltd. (241). Exhibits of aviation fuelling equipment include the new LBM 1000 bulkmeter (capacity 1,500 i.g.p.m.) for the large-scale movement of fuels; bulkmeters and meters for test rigs, refuellers and hydrant dispensers; quick-release self-sealing couplings for most industrial liquids; automatic bottom loading equipment for bulk vehicle distribution.

Aviation Developments, Ltd. (6). Latest development is the Huckbolt fastener which was introduced at the last S.B.A.C. show. Other products include the Avdel self-sealing blind rivet; the Jo-Bolt high strength fastener; the Avlock blind anchor nut; and the Chobert rivet.

Avica Equipment, Ltd. (256). New products on display include gimbal-type stainless-steel flexible joints; stainless-steel flexible assemblies with welded end connections; mechanical tube fittings.



The Avica On Mark flexible coupling in a rigid tube line with the Avica rigid tube coupling, bolted flange type, at one end.

Bakelite, Ltd. (135). Products include nose-cone of English Electric Thunderbird guided missile in Bakelite polyester resins, and other guided-weapon components using alkyd and phenolic materials; polyester/glass, silicon, melamine glass-fibre, P.V.C. and polyethylene components for aircraft applications.

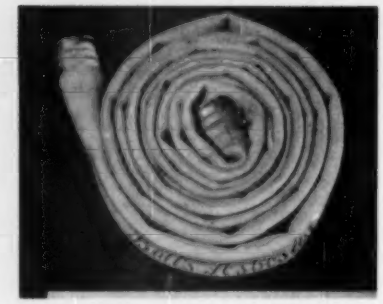
Baxter Woodhouse and Taylor, Ltd. (64). Stand includes Falconia flexible ducting for cabin air distribution, and the combination of this with insulation in a preformed bag, making a flexible self-contained unit which is easily installed; the Taylor partial pressure helmet on its associated test rig; leading-edge electric anti-icing heaters, component heated muffs and aircraft floor heaters.

B.B. Chemical Co., Ltd. (72). Bostik sealing compounds based on synthetic rubbers for pressure cabin and integral fuel tank sealing; glazing of laminated screens; sealing of ancillary electrical equipment. Bostik adhesives for assembly of helicopter rotor blades; attachment of de-icer shoes to propeller blades; manufacture of inflatable survival equipment; upholstery and trim work.

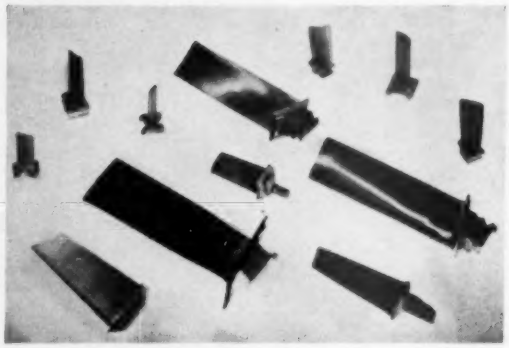
Bell Precision Engineering Co., Ltd. (226). Special tools for the aircraft industry.

Bell's Asbestos and Engineering, Ltd. (92). New products on show include a collapsible air starting hose for turbojets; a stainless steel wire mesh fire seal; a new type of universal clamp for "V" flange joints. Also exhibited are improved versions of a "D" section fire seal; garter spring fire seals; silicone and glass-fibre connecting sleeves; and silicone and glass-fabric flexible hoses.

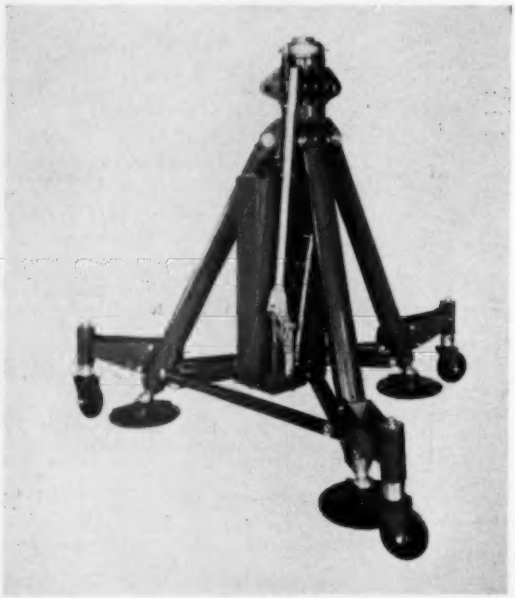
Guide to the Static Displays . . . .



A collapsible air starting hose recently developed by Bell's Asbestos and Engineering to meet the requirements of modern large jet engines.



Selection of the range of turbine blades produced by the B.R.D. Company.



A Brown Brothers (Aircraft) Rotheswan standard 40-ton jack for the D.H. Comet. (Left)

Mounted on a 15-cwt. Commer vehicle is this self-propelled version of the Blackburn Palouste turbo-starter trolley. (Below)

Belling and Lee, Ltd. (194). The stand features the company's range of sub-miniature electronic components for guided missiles and their ground equipment, as well as its range of standard Unitor plugs and sockets. Other components on display include the L.1403 range of sub-miniature coaxial plugs and sockets and miniature coaxial connectors.

Birmetals, Ltd. (144). Exhibits include extruded sections in both aluminium and magnesium alloys together with samples of aluminium alloy sheet pre-treated with protective coverings of different types.

Birmingham Aluminium Casting (1903) Co., Ltd. (156). Castings by the sand, gravity die, and pressure die processes in aluminium and magnesium alloys to B.S. specifications, including the latest magnesium-zirconium and thorium alloys.

The Blackburn Group, Ltd. (P and O.D.S. C and 16). A.129 free-turbine engine; Turmo 600 free-turbine engine; an airborne auxiliary power unit as installed in the Victor 2 and Canadair CL-44; a sectioned Palas gas generator; Palouste engine starter trolleys, including one incorporating electrical supply; a starter truck containing a Palouste gas turbine; transportable turbo-alternator emergency power set; an airborne pod version of the starter trolley.

James Booth and Co., Ltd. (184). A general range of extruded sections, sheet, plate, tubes and large aircraft forgings in Duralumin and other Booth aluminium alloys. The display is supported by photo transparencies of some of the famous aircraft in which the company's material is used.

Boulton Paul Aircraft, Ltd. (A). Various aspects of aircraft control including a control fan for VTOL aircraft; a rotary control valve; elevon-powered flying-control unit for Vulcan B.2; a complete set of powered flying-control units for N.A.39. Other exhibits cover the Pendeford Multimeter Mk. 2; differential manometer; acceleration measuring equipment; transducers.

B.P. Trading, Ltd. (142). The company's exhibit features B.P.-Shell service to aviation.

R. A. Brand and Co., Ltd. (280). The company's three main types of reusable protective covers for aero-engines are illustrated. A further exhibit includes the latest development in sprayed skins—their application to building structures in the electronics industry to secure absolute exclusion of dust.

B.R.D. Co., Ltd. (234). A complete range of gas- and steam-turbine blades, discs and complete rotor assemblies covering all known materials used by the turbine industry and produced on specialized plant without restriction as to size. Fully machined integral discs for industrial gas turbines will be a new feature of this particular section. Other products on view are constant-velocity joints, with special applications for the aircraft field.

Brent Chemical Products, Ltd. (55). New products added to the company's range since September, 1958, include electrical cleaning material, white strippable lacquer, blue marking-ink and magnetic particle inspection fluids. Water-rinsable paint remover and flow-detection materials are also on show.

Bristol Aerojet, Ltd. (237). Exhibits include a selection of rocket motor cases in high-tensile steel and resin-impregnated glass-fibre and high-pressure storage vessels for guided missiles and aircraft. A model of a propulsion test vehicle developed by Bristol Aerojet for the Canadian Defence Research Board will also be on show.

Bristol Aircraft, Ltd. (R and 154). Represented in the fields of transport aircraft, helicopters, guided missiles, plastics and electronic equipment. Models on show include Britannia 252 and 307, Type 192 helicopter and Bloodhound missile. Exhibited on Stand 154 are plastic drop tanks, a fluted core plastic radome and items of electronic equipment. Also on show for the first time is a sectioned Bloodhound revealing a considerable amount of the interior of the missile which has hitherto been classified.

Bristol Siddeley Engines, Ltd. (D). Olympus, Orpheus B Or.12 and Viper A.S.V. 11 turbojet engines; Proteus 765 turboprop; Thor BT-1 ramjet; Gamma and PR-23

rocket engines; GTCP-85 and GTP-30 gas-turbine power units; models of the ATS 100 air-turbine starter and the ATSC 100 air-turbine/cartridge starter; a Beaver ball screw representing the company's range of recirculating ball screws and splines.

The British Aluminium Co., Ltd. (170). Special features of this stand are wide plate for aircraft construction and P-G-P non-slip treadplates for freighter floorings, gangways, etc.

The British Ermeto Corpn., Ltd. (140). Manufacturers of high-pressure couplings, shut-off and flow-control valves.

British Insulated Callender's Cables, Ltd. (165). Manufacturers of aircraft wiring cables; ignition cables and thermocouple leads; radio frequency cables; cables for airfield lighting; connecting and winding wires; radio capacitors; aluminium wire, sheets and strands.

British Manufactured Bearings Co., Ltd. (202). Products include high-precision miniature ball bearings, pressurized assembly cabinets and vacuum cabinets, assembly and handling tools.

British Manufacture and Research Co., Ltd. (49). On show are various marks of Hispano Suiza guns and feed mechanisms, together with short belts of inert ammunition representative of the types required for the different guns.

British Messier, Ltd. (29). See Dowty Group.

British Oxygen Aviation Services (191, 192 and O.D.S. S). The exhibit surveys the aviation services provided by British Oxygen Group companies in the fields of ground and aircraft equipment, research and development. The distribution, storage and dispensing of oxygen and other gases will be illustrated; exhibits will include representative oxygen systems and a liquid-nitrogen explosion-suppression system.

British Paints, Ltd. (129). High-temperature sealants for integral fuel tanks which will experience up to 450° F. in service; synthetic rubber coatings and sealants for electrical connectors; printed circuits and assemblies; and Pyles equipment for mixing and applying two component resins, elastomers and foams.

British Refrasil Co., Ltd. (216). On show are samples of aircraft heat-insulation blankets—in particular for the insulation of jet-engine tail pipes—and high-temperature materials for both thermal and electrical insulation. These include Refrasil, a pure silica fibre, and Astrasil, laminates or mouldings of Refrasil cloth impregnated with a resin binder. Also exhibited are temperature-compensating couplings and Toruseals—pipe couplings and O-rings designed to make and seal joints that become more effective as the temperature and pressure of the pipe increase—and high-temperature bonding clips, and all-welded stainless steel honeycomb core.

British Thomson-Houston Co., Ltd. (272). The two main features on this stand are a complete AC/DC aircraft electrical generating system, and an iso-propyl nitrate turbine-engine starting system. In addition there are high-energy ignition units; a silicon power rectifier; a range of AC and DC motors; a selection of switchgear and electronic devices.

J. Brockhouse and Co., Ltd. (O.D.S. Q). Products include engineers' small tools. Warwick cold-rolled sections; airfield sweeper/sprinkler/collectors and tractor-drawn sweepers for airfield cleaning.

Brown Bayley Steels, Ltd. (36). Forged and rough-turned rings; black rolled descaled and bright ground bar; stainless steel sheet in various finishes. Also displayed are spacing rings for Avon and Tyne engines, machined by Rolls-Royce from forged rings supplied by the company.

Brown Brothers (Aircraft), Ltd. (161 and O.D.S. 5). In addition to the standard range of Rotheswan Aerojacks of 3- to 40-ton capacity, power-operated jacks for Britannia, Comet, Vanguard, Vickers VC.10 and Boeing 707 are on display, together with the power unit for use with these 40-ton capacity jacks. Nose-wheel jacks are also on view. On the company's stand is a display of standard AGS, BS, and SBAC parts, Hi-shear pins and collars, Oddie stiff-nuts, Hy-seal special pressure-sealed couplings, machined parts and aircraft metals.

David Brown Industries, Ltd. (175 and O.D.S. D). Producers of all types of gears and gear units; machine tools and castings. A Turbo-Taskmaster Super aircraft-towing tractor is shown outside.

S. G. Brown, Ltd. (78). Master Reference Gyros Mk. 1 and 2; Arma Brown floating gyro; precision gears; servo motors; servo amplifier and power pack; precision potentiometers; tuning fork, oscillator and frequency divider.

Bryans Aeroquipment, Ltd. (204). Latest equipment on show includes an accelerometer tester for small instruments up to 20 lb. in weight; an X and Y co-ordinate plotting table; and an airspeed-indicator control panel for use in the ground testing and calibration of A.S.I.s.

The Baxter, Woodhouse and Taylor partial pressure helmet, which is now in production.

Burgess Products Co., Ltd. (7). Products include exhaust and cabin blower silencers, air cleaners, aircraft-cabin soundproofing, precision switches for aircraft and ground application, and vibro tools for engraving.

Burndept, Ltd. (54). On the stand is the company's BE 255 five-channel VHF light-weight airborne transmitter/receiver. Designed to meet the requirements of light aircraft, this equipment has a frequency range of 118-132 Mc/s. and a power output of 1 watt unmodulated. It weighs 6¼ lb. and costs £97 10s. without crystals.

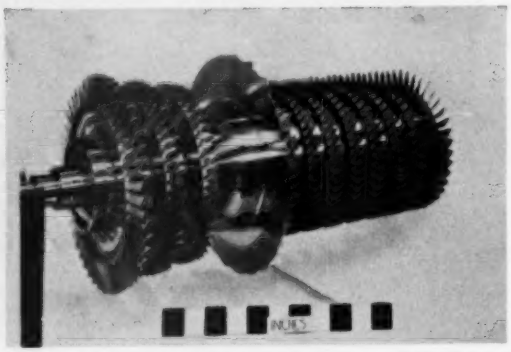
Canadian Marconi Co., Ltd. (15). See Marconi's Wireless Telegraph Co., Ltd.

Cellon, Ltd. (160). Full range of approved aircraft dopes and finishes conforming to A.I.D. and A.R.B. requirements; latest developments in the Cellon cold-catalysed resistant finishes for high-speed aircraft, crop-spraying aircraft and guided missiles; Cellon water-resistant primer, heat-resistant paints, chemical milling materials and sealant for magnesium protection; fluorescent colours for anti-collision finishes.

Right, Bristol Aerojet high-pressure gas storage vessels are on show. In this illustration strands of glass fibre from a number of bobbins are being gathered into a ribbon before being wound on to a sphere.

Below, the B.T.H. (A.E.I.) turbo-starter system for aircraft.

Guide to the Static Displays . . . .



One example of the manufacturing capacity of Centrax, Ltd., is this gas turbine rotating assembly.

Cementation (Muffelite), Ltd. (38). Barry-mount range of anti-vibration and shock mounts for airborne equipment. Illustrations and details of the vibration and shock testing facilities available to industry at the company's laboratory at Hersham.

Centrax, Ltd. (121). Principal exhibits are high-precision compressor blading for gas turbines and hardened ground spur and helical gears. In addition, there is a new line of high-temperature-brazed components, including heat exchangers, tip shroud rings and de-icing vanes.

Chelton (Electrostatics), Ltd. (239). Chelton aircraft aerial equipment, including HF, MF and ADF aerial masts, tension units and line insulators. Among new equipment will be the Midget static discharger. Typical aerial arrays will also be displayed.

The Chesterfield Tube Co., Ltd. (277). Seamless steel and light-alloy gas cylinders for airborne and ground installations; precision seamless steel rocket-motor tubes; extrusions in ferrous and rare metals; beryllium tubes and rods; alloy-steel undercarriage tubes.

J. S. Chinn and Co., Ltd. (70). A set of Centaurus engine cowls manufactured from aluminium alloy; Proteus cowling beam and front diaphragm assembly in titanium, stainless steel and aluminium alloy; shroud boxes and heat shields; various transfer tubes and breather tubes; machined parts and investment castings.

CIBA (A.R.L.), Ltd. (68). Specimens illustrating uses of Araldite epoxy resins occupy the greater part of the stand. Components incorporating Redux and Hidux adhesives for aircraft structures and Aeroweb metal honeycomb core are displayed, and data are provided on the range of new Hidux adhesives. A working photoelastic model shows the stress distribution in riveted joints.

E. K. Cole, Ltd. (186 and O.D.S. R.). The Ekco type CE178 VHF/ADF equipment and the Ekco airfield approach aid are featured on the outdoor stand and transistor inverters are shown on the indoor display.

Connolly Bros. (Curriers), Ltd. (217). Vaumol-brand leather for upholstery and panelling and general furnishing of aircraft and for furniture and decoration in airports and terminal buildings.

Coopers Mechanical Joints, Ltd. (41). Exhibits include fuel, lubricating oil and air filters; air breathers; gauze strainers and screens; gaskets; shims in various metals; washers in folded copper, steel, copper and asbestos; cork and synthetic rubber materials; light pressings and assemblies.

A. C. Cossor, Ltd. (231, O.D.S.17, and R.D.S.). Wind-finding radar; secondary surveillance radar; air traffic control display system.

Bristol Proteus fixed beam and front diaphragm assembly manufactured by J. S. Chinn and Co.

John Curran, Ltd. (11). A scale model of the company's latest turbojet test stand, the Mk. 1c, together with information on a new remotely controlled mobile carrier crane, a flight-deck arrester barrier, an acceleration test machine and several neutron diffraction spectrometers.

Decca Radar, Ltd. (58 and R.D.S.), and **The Decca Navigator Co., Ltd.** (59). Equipment on view includes the Decca HF 200 height-finding radar, one of the largest radars ever brought to Farnborough, and a 3 cm. wind-finding radar. The HF 200 is a 10 cm. nodding height-finder of high performance, suitable for defence or civil use. The new Decca Navigator Mark 10 receiver, engineered to the ARINC specification, together with the Mark 8 and the lightweight Mark 9 receivers.

The de Havilland Enterprise and **de Havilland Propellers, Ltd.** (G and 252). Range of equipment for the Firestreak AAM; propellers for the CL-44 Argus and Gnome; models of Caribou, Beaver, Otter, Vampire Trainer and Sea Vixen are displayed on the main stand together with Gnome, Gyron Junior and Gipsy Major powerplants and Double Spectre rocket engine. Other exhibits are the Gnome fuel system; air conditioning system for full pressure suits; hydraulic system for aircraft alternator and radar scanner drive, and a vapour cycle cooling system; these are on public display for the first time on stand 252.

Delaney Gallay, Ltd. (268 and O.D.S.8). Oil coolers; heat exchangers for anti-icing and cabin heating; thermal insulation blankets and ducting; stainless steel aircraft toilets; examples of flux bath and vacuum furnace brazing; Incorporall portable welding kit.

Desoutter Brothers, Ltd. (250). Four new portable pneumatic power tools are exhibited at Farnborough for the first time. These are a reversible screwdriver, a corner screwdriver and nutrunner, a grinder and a reversible corner nutrunner.

Dexion, Ltd. (O.D.S. 19 and A). Manufacturers of steel and light-alloy cold-rolled slotted angle for high- or low-stressed fabrications; special-process tanks and degreasing units.

Docker Brothers (151). The company's stand features surface coatings and allied materials which have been specially formulated for the protection and interior décor of transport aircraft. They include the Dockerlight range of lightweight protections; stoving finishes; protective finishes such as hammer, wrinkle and textured materials; jointing paste and compounds; fluorescent paints.

Dowty Group, Ltd. (31-34). Companies of the Group exhibiting are **Dowty Equipment, Ltd., Dowty Fuel Systems, Ltd., Dowty Equipment of Canada, Ltd., Rotol, Ltd., British Messier, Ltd.,** and **Dowty Seals, Ltd.** Undercarriages and nosewheels for the Argosy and N.A.39, and for supersonic interceptor fighters; hydraulic equipment for aircraft and missiles; an Argosy propeller and sectioned propeller-hub assembly for the Viscount; Vanguard gearbox with mounting faces for various accessories; animated circuit diagram illustrating spill burner principles, fuel systems for the Gyron Junior, and a selection of components including fuel pumps, spill nozzles and a complete spill system; ram-air turbine for providing emergency power supply for essential flying controls; 40-kVA. hydro-mechanical constant-speed drive; a wide range of electrical equipment comprising switches, two- and three-position magnetic indicators, press-to-test indicators, undercarriage-position indicators, switches and solenoids; a display of new developments in rubber compounds and examples of Dowty sealing components in natural, synthetic and silicone rubbers.

The Handley Page Victor main undercarriage designed and manufactured by Electro-Hydraulics.

Dunlop Rubber Co., Ltd. (42). New exhibits include a fan-cooled aircraft wheel brake, which reduces cooling time by as much as 80%, and a range of collapsible rubberized fabric containers, which allow

any aircraft to be used as a tanker for conveying liquids without any modification of the cargo compartment. A new range of compressors for ground charging pneumatic systems will be shown, as well as inflatable seals for protecting jet-engine intakes, and the latest types of aircraft tyres, wheels, brakes, Maxaret anti-skid units, pneumatic components, de-icing equipment, and rubber accessories.

Dzus Fastener Europe, Ltd. (128). Range of Dzus fasteners, including the well-known self-ejecting type, Supersonic and general-purpose fasteners. Of particular interest is the tension fastener and the panel-mounting fastener and strip.

H. W. Edghill and Co., Ltd. (O.D.S. 10 and L). Products include aircraft servicing, operational and production-line equipment.

Ekco Electronics, Ltd. (187). On display is a new transistorized airborne weather radar with a weight of 56 lb. which employs only three main units—indicator, transmitter/receiver and scanner. This equipment is less than half the weight of the previous Ekco system.

Electro-Hydraulics, Ltd. (162). Exhibits include a Victor main undercarriage shown retracted; film of aircraft landings and drop testing; hydraulic selectors, brake control valves and other hydraulic components for aircraft and guided weapons; specimens in 115-ton high-tensile steel.

Electro Mechanisms, Ltd. (232). Exhibiting for the first time at Farnborough, this company's most recent developments include piezo-electric transducers; miniature and differential pressure transducers; carrier amplifier equipment with its variety of plug-in units, and Smoothrator.

W.S. Electronics (Production), Ltd. (215). Display includes UHF airborne transmitter/receiver transistor power supplies; electronic tuning and associated homer equipment; UHF airborne telemetry transmitter; UHF/VHF airborne emergency transmitter/receiver; airfield security two-way communications system.

Elliott Brothers (London), Ltd. (Radar Division) (136 and O.D.S. 7). Principal exhibits are the 21 series VHF communication and VOR/ILS navigation equipment, the E-RDR-1D airborne weather radar system; an aircraft interphone system; passenger address equipment.

Elliott Brothers (London), Ltd. (218 and O.D.S. 7). Model of the Vickers VC.10 showing the position and operation of the various Elliott-Bendix equipment to be fitted to the aircraft, including auto-stabilization, autopilot, flight-director system and fuel-flow metering equipment. Also on display is the fully integrated central air reference system; electro/hydraulic servo systems; transistorized voltage regulators and the Bendix turbine engine analyser. The Inertia Navigation Division show a display model of a flight path of an inertially guided missile.

E.M.O. Instrumentation, Ltd. (195). Torque-testing machine for measuring accurately the starting and running torques of precision bearings and complete synchros; precision bearings to ABEC 5 and 7 specifications and to British and American specifications.

The English Electric Co., Ltd. (O, 282, 283 and 284). Ten years of the Canberra; models of the single- and two-seater Lightning. The landing of the Thunderbird unit on a landing craft (seaborne); deployed behind front line; and the moving to another position. Also shown is an electronic pack and aircraft equipment, including five new items.

English Steel Corporation, Ltd. (273). Selection of drop-forged components for airframes, engines and propellers; finished units made from E.S.C. special aircraft steels; engineers' cutting tools; and permanent magnets for instruments, radar and other electrical equipment. Theme of the complete display is the Corporation's long association with the aircraft industry.

E.N.V. Engineering Co., Ltd. (263). Examples of precision spiral-bevel and spur gears with emphasis on spiral-bevel gears with profile ground teeth for helicopter rotor drives. Interesting drives for Continental production and experimental helicopters are also shown, together with precision gears for engine-accessory drives, propeller reduction-gear units and for flying controls.

Esso Petroleum Co., Ltd. (179 and O.D.S. O). The stand takes the form of an advisory bureau where the company's technical staff will discuss any problems concerned with purchase, handling, storage and use of the Esso fuels and lubricants produced for the aviation industry.

Ferranti, Ltd. (105 and 106). On display for the first time at Farnborough is the Ferranti Airpass airborne radar and fire-control equipment. Aircraft instruments, including a vertical reference gyro, stand-by artificial horizon and a stand-by gyro system; a colour transparency of the Pegasus data-processing system; silicon semi-conductors; and guided-weapon components are also exhibited.

Dennis Ferranti Meters, Ltd. (102). Products include electrical armament and oxygen equipment such as voltage regulators, distributors, release units, and economizers; electronic instrumentation; test equipment; glass - fibre - reinforced laminates; Ear Defenders.

Fibreglass, Ltd. (20). Products include fibreglass insulation and reinforced plastics for aircraft.

Field Aircraft Services, Ltd. (227). The company's customers are indicated by points of light on two world globes, whilst the background of the stand consists of coloured transparencies of the various divisions and sections within the organization, which sells, repairs, modifies and overhauls aircraft, instruments, accessories and engines.

Fireproof Tanks, Ltd. (271). A typical flexible fuel tank in lightweight ozone-resistant, reinforced Hycatrol and a flexible fuel tank in a special grade of P.V.C. compatible with high test peroxide. A special feature is a model showing the company's helicopter pontoons constructed by a high-frequency welding of nylon-terylene sheet material. Other items include a drop fuel bag, lightweight flexible containers and flexible mouldings.

The new Foamite-Austin Gipsy water/foam tender. In addition to driver and crew in front, there are two crew member seats at the rear.

Exactor, Ltd. (52). Products include test-rigs; portable pumping and filtration units; self-sealing pipe connections; missile-launching equipment; drop-tank self-sealing connections and balanced couplings.

Export Packing Service, Ltd. (125). Specialists in the packing of aircraft components, radio and electronic equipment.

The Fairey Aviation Co., Ltd. (K and 206). Model of Rolls-Royce Tyne-powered Rotodyne with examples of the varied loads which the aircraft will be capable of carrying and the Fairey anti-tank missile are on the main stand. On stand 206 the company's Hydraulics Division is showing an electrically signalled servo valve; microfilters for aircraft and industrial servo-mechanism circuits; castings in high-tensile steel for aircraft structural parts; Australian-designed target cameras.

Firestone Tyre and Rubber Co., Ltd. (99). Selection of aircraft tyres including ribbed and gear-grip tubed and tubeless tyres, and an example of a new tyre for the Boeing 707, which has a high-speed tread with a straight ribbed pattern.

T. F. Firth and Sons, Ltd. (18). Makers of upholstery fabrics and carpeting for aircraft cabins.

Thos. Firth and John Brown, Ltd. (243), and **Firth-Derihon Stampings, Ltd.** (244). Joint display featuring high-grade alloy steels; drop and press forgings, forging dies. Fully bladed rotating Olympus disc and various other gas turbine discs.

Firth-Vickers Stainless Steels, Ltd. (149). Examples of the many different types of materials manufactured by the company, including bars, sheets, centrispinnings and static and precision castings in heat and creep resisting steels. Precision steel castings; set of aviation gyroscope components; examples of centrispun steel castings.

The new high-speed hydraulic refueller, built by Steel Barrel Co., Ltd., which has been introduced by Esso to meet the increasing fuel capacity of modern aircraft. With a high pumping rate of over 1,000 g.p.m. this refueller can refuel a Viscount in less than two minutes, a Comet in less than eight and a Boeing 707 in 12.

Guide to the Static Displays . . . .

Flight Equipment and Engineering, Ltd. (213). Exhibiting for the first time at Farnborough, this company is showing a triple Viscount seat, a Payloader double folding seat and a supernumerary crew seat.

Flight Refuelling, Ltd. (167). On display is a new concept of flight refuelling in the form of the Mk. 20 refuelling pack; a scale model of the Meteor U.16 target aircraft; a range of aircraft components including a new 2-in. air engine starter connection, a new 4-in. hydrant refuelling coupling, a new inverted flight switch and various fuel valves.

Howard Flint, Ltd. (85). Manufacturers of flying clothing.

Folland Aircraft, Ltd. (C). Exhibit includes a full-scale mock-up of Gnat Trainer cockpit; ¼-scale models of Gnat Mk. 1 fighter and Gnat Trainer, and components of the Gnat which illustrate lightness and simplicity of design. These include gun blast suppressor; wing root-rib assembly; an aluminium-alloy frame forging; portions of feed chute and link chute for 30 mm. Aden guns; glass-fibre radar nose cone; windscreen casting; portion of welded-magnesium air-intake duct.

Fothergill and Harvey (Sales), Ltd. (219). A wide selection of technical and industrial fabrics for the production of reinforced plastics; two of the most important exhibits show pre-impregnated glass fabrics and three-dimensional woven shapes.

Samuel Fox and Co., Ltd. (132). A joint display with **Steel, Peach and Tozer, Ltd.**, includes a forged steel end closure for a rocket motor, a propeller bearing incorporating forged steel rings, a jet-engine combustion chamber and a selection of rolled steel rings used in gas turbine engines.

P. Frankenstein and Sons (Manchester), Ltd. (117). Manufacturers of inflatable life-saving jackets, flying and survival clothing; high-altitude equipment.

Garringtons, Ltd. (233). Products include compressor and turbine blades forged to oversize, close or precision limits in various alloys; hand tools for the aircraft industry.

The Gear Grinding Co., Ltd. (209). Emphasis is on precision gears, particularly of helicopter gears. The centre piece of the show is a rotary table displaying a helical annulus ring gear; miscellaneous items including drive gears for the Westland Westminster and gears for the Wessex and Whirlwind.

General Electric Co., Ltd. (23, 24). Aircraft catering equipment including a new hot cupboard; airport lighting equipment; airborne electronic units and instruments; Multiplex equipment for use in conjunction with new R.A.F. airfield arrester-barrier system; altitude recorder; Seaslug guidance equipment; sections of the Stardac computer.

Girdlestone Pumps, Ltd. (96). New at the S.B.A.C. show, the company is displaying VHF aerials for high-speed aircraft; moulded connectors covering a wide range of requirements, including radar and radio equipment, missile ground installations and instrument leads; plastic nuts for preventing "drift" of potentiometer spindles subjected to vibration; pumps used for various purposes in the aircraft industry.

Girling, Ltd. (236). A telescopic damping unit; control dampers for aerofoil surfaces; a Scimitar rudder and tail fin; an aircraft control column with a damper incorporated.

Sir George Godfrey and Partners, Ltd. (21 and O.D.S. 6), and **Godfrey Engineering Co., Ltd.** (22). A new exhibit is an airborne vapour-cycle refrigeration package which is in production for two military aircraft. Also on view are two air cycle sets for missile cooling; a pneumatically operated mechanical arm for supplying cooling air and electrical power to a missile before launching is shown for the first time. Other exhibits include representative items of Godfrey equipment in production for the Vanguard, Argosy and other aircraft.

Goodmans Industries, Ltd. (199). A complete vibration testing system featuring a 10,000 lb. thrust vibrator driven from an automatic sweep oscillator is on view. The demonstration includes a control amplifier, an autostrobe and stroboflash unit and a group of C.R.O. display units. A large photograph of a custom-built system together with cut-away and exploded views of large vibrators are also shown.

The Goodyear Tyre and Rubber Co. (Great Britain), Ltd. (164). On display for the first time are fabric reinforced tread tyres for high-speed aircraft. Also exhibited are Goodyear smooth bore high pressure aircraft refuelling hose; an hydraulic/pneumatic convertor; anti-skid and skid warning systems; and a helicopter rotor brake and other units.

G.Q. Parachute Co., Ltd. (50). A recently designed flexible lightweight parachute incorporating an 18 ft. 6 in. diameter canopy in ripstop nylon, complete with automatic release mechanism as used on Sabres; a fully automatic aircrew safety harness based on the type 2 design; air ventilated units and high-altitude flying equipment. A photographic display covers the company's latest supply-dropping equipment and aircraft braking parachutes.

Graseby Instruments, Ltd. (278). Guided missile and control equipment comprising accelerometers; accelerometer recorders; three-axis accelerometer units; programme switches; rate gyros; yaw meters; pressure transducers and high pressure valves; and a new range of gyroscopic test equipment including servoed gimbal universal tester and polar axis tester and ancillary equipment.

Graviner Manufacturing, Co., Ltd. (247). Exhibit emphasizes the company's consultant and other services to the aircraft industry. Among the latest equipment to be seen is the DC Firewire control unit; a chrome molybdenum steel extinguisher bottle containing bromotrifluoromethane pressurized to 400 p.s.i. at 20° C. which will be used in the Vickers Vanguard, and a crashtrip variant for the Blackburn N.A.39.

Grundy and Partners, Ltd. (97). Displays include radio connectors, cable assemblies, looms, junction boxes and a new portable flight recorder using magnetic tape specially designed to cover a wide range of testing on all aspects of aircraft performance.

Guest, Keen and Nettlefolds (Midlands), Ltd. (126). A new development in this company's wide range of fasteners for the aircraft industry is the redesigned locating screw, the head of which is now made of nylon with a socket in it to allow a wrench to be used for tightening.

(*Continued on page 125*)

The Field Aircraft Services stand in the exhibition is very similar to this illustration of the company's display at last year's show. (Right)

British Oxygen Aro Equipment, in collaboration with the Walter Kidde Co., is developing a breathing oxygen system using liquid oxygen storage. Illustration shows the Walter Kidde equipment as fitted in the Comet 4. (Below)

A Flexibox lapping machine Mk.4 for the precision lapping of metal, plastic and ceramic components.

Farnborough Portfolio

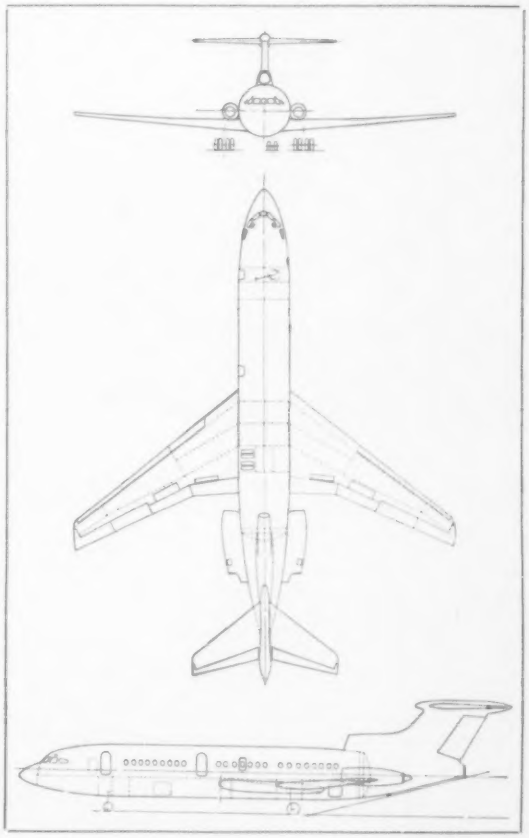
Here follow sixteen pages of a specially prepared portfolio of exclusive copyright cutaway drawings or artist's impressions of new exhibits at the twentieth S.B.A.C. Show. Not all of these will be in the air. The new D.H.121 and the Avro 748 will have to be studied in model form; on the other hand the Hovercraft and the Sea Vixen will be seen in action. The Gamma quadruple rocket motor will be available for study in the static exhibition.

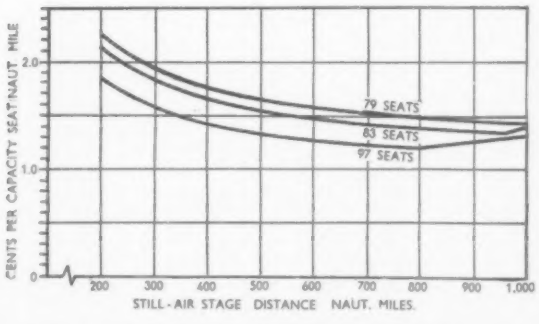
The D.H.121 Short-haul Turbojet

BRITISH aircraft manufacturers, in collaboration with British airlines, have been responsible, in the past 10 years, for the design, production and introduction of the World's first turbojet and turboprop transports. Now, British European Airways has become the first airline to order a genuinely short-haul turbojet design—the Airco D.H.121. There is evidence that, in this case, British pioneering will be strongly challenged by the American industry with the Douglas DC-9 and perhaps the Boeing 727 also. After de Havilland, Douglas is the first company to announce positive plans for a second-generation turbojet and although no firm orders for the DC-9 have yet been placed the company promises to match the D.H.121 target in-service date of 1963 providing sufficient orders are obtained to justify an early start of production.

The Airco D.H.121 has several unique features which command attention. Most obvious of these is the three-engined configuration, which is made possible only by the choice of rear-fuselage mounting, but confers several important advantages in an aeroplane of this particular size and performance. By dividing the cruise power requirement among three engines, the best possible take-off performance can be obtained for the minimum outlay of capital and maintenance costs. The benefit to cabin noise has already been demonstrated in the Caravelle. The engines to be used are R.B.163s—this 10,100-lb.s.t. project being a new member of the Rolls-Royce by-pass family, tailored to fit the D.H.121 and with a higher by-pass ratio than the Conway and R.B.141.

De Havilland have "optimized" the D.H.121 design for short-haul operations, the maximum stage distance with full payload being 1,200 s.t. miles. Although it might be possible to increase this range a little in due course, the design philosophy behind the D.H.121 has been to provide the smallest possible aeroplane for stages of 200 to 1,200 miles, with benefit to the operating costs. Market surveys indicate that more than half of all airline traffic moves over these distances, and in keeping with this kind of short-haul operation the maximum landing weight has been set at 95% of the gross weight, to permit multi-sector operation without intermediate refuelling.





Direct operating costs, based on the A.T.A. method with 10 years depreciation and 15% residual value, assuming cost economical cruise at 32,000 ft. and no freight.

The D.H.121 is based on a wing with 35° sweepback, the design of which has been uncomplicated by powerplant considerations. Front and rear spars make up the primary torsion box containing integral fuel tanks, and a supplementary spar is used in the centre section and inner wings.

The main undercarriage units, each with four wheels abreast, pick up on the rear spar and pivot through 90° before folding inwards; the wheels themselves lie in the fuselage when retracted and the nosewheel, also for simpler stowage, is offset from the centre line and retracts sideways.

The fuselage is a circular-section monocoque, with pressure bulkheads ahead of the flight deck and aft of the wing

D.H.121

Dimensions
Span: 89 ft. 10 in.
Overall length: 114 ft. 9 in.
Overall height: 27 ft. 6 in.
Gross wing area: 1,350 sq. ft.
Sweepback: 35° at 25% chord.
Internal cabin dimensions:
Length (ex. flight deck): 64 ft.
Max. width: 139½ in.
Max. height: 80 in.

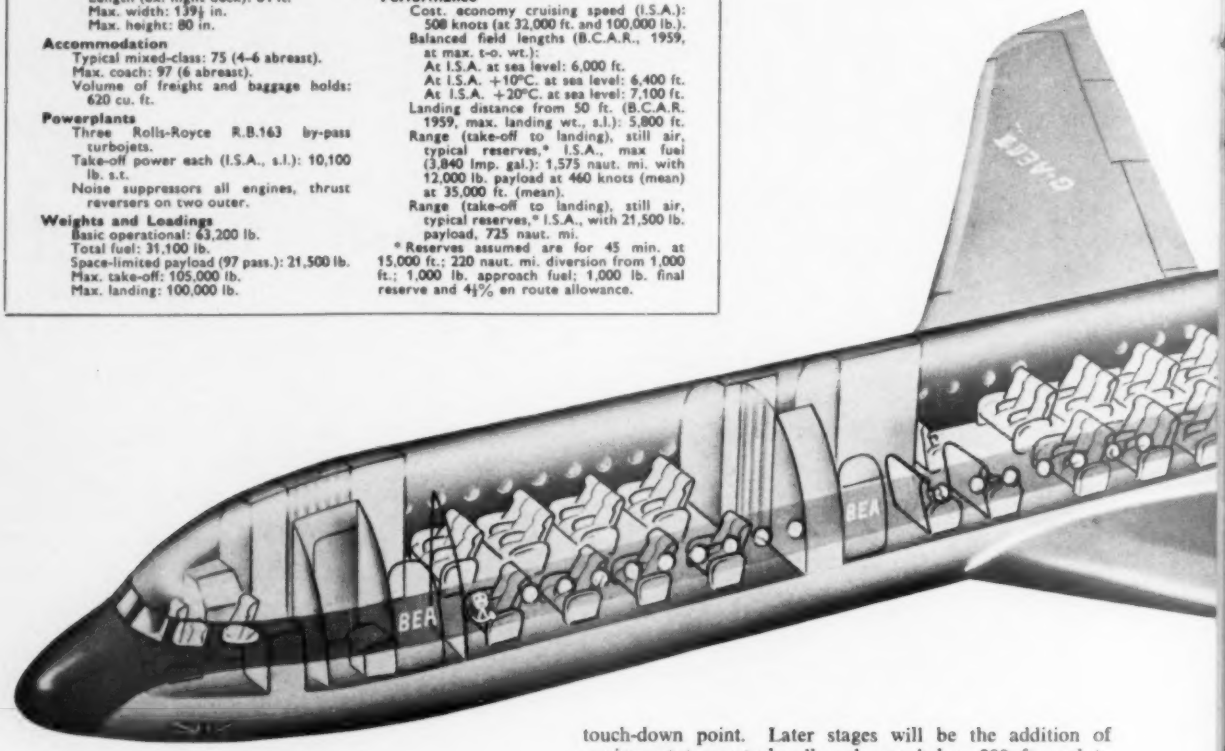
Accommodation
Typical mixed-class: 75 (4-6 abreast).
Max. coach: 97 (6 abreast).
Volume of freight and baggage holds: 620 cu. ft.

Powerplants
Three Rolls-Royce R.B.163 by-pass turbojets.
Take-off power each (I.S.A., s.l.): 10,100 lb. s.t.
Noise suppressors all engines, thrust reversers on two outer.

Weights and Loadings
Basic operational: 63,200 lb.
Total fuel: 31,100 lb.
Space-limited payload (97 pass.): 21,500 lb.
Max. take-off: 105,000 lb.
Max. landing: 100,000 lb.
Max. zero fuel: 85,000 lb.
Wing loading (max. t-o. wt.): 77.8 lb./sq. ft.
Wing loading (max. landing wt.): 74.1 lb./sq. ft.
Power loading (max. t-o. wt.): 3.46 lb./lb. s.t.

Performance
Cost. economy cruising speed (I.S.A.): 508 knots (at 32,000 ft. and 100,000 lb.).
Balanced field lengths (B.C.A.R., 1959, at max. t-o. wt.):
At I.S.A. at sea level: 6,000 ft.
At I.S.A. +10°C. at sea level: 6,400 ft.
At I.S.A. +20°C. at sea level: 7,100 ft.
Landing distance from 50 ft. (B.C.A.R. 1959, max. landing wt., s.l.): 5,800 ft.
Range (take-off to landing), still air, typical reserves,* I.S.A., max fuel (3,840 Imp. gal.): 1,575 naut. mi. with 12,000 lb. payload at 460 knots (mean) at 35,000 ft. (mean).
Range (take-off to landing), still air, typical reserves,* I.S.A., with 21,500 lb. payload, 725 naut. mi.

* Reserves assumed are for 45 min. at 15,000 ft.; 220 naut. mi. diversion from 1,000 ft.; 1,000 lb. approach fuel; 1,000 lb. final reserve and 4½% en route allowance.



trailing edge. The central engine is contained in the rear fuselage in what amounts to an enclosed pod behind all major structure. Structural material, for the most part, will be naturally aged aluminium-copper alloys. The primary structure will be designed to have duplicated members or crack-stoppers, with adequate safe lives for those portions where alternative load paths are not practicable, or which are not readily inspectable.

For lateral control, the D.H.121 has split ailerons, the inner portions operating alone at high Mach numbers. Large double-slotted flaps are provided and these work in conjunction with the leading-edge flaps. Conventional air brakes lie ahead of the flaps, and can be used to supplement the "lift dumpers," for use on landing. In the air, the undercarriage and engine reverse thrust can also be used for braking.

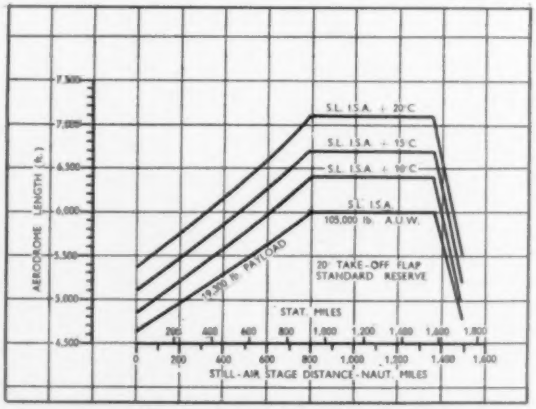
The tailplane is of the all-moving type with a geared elevator. All controls are fully powered. Three completely separate 3,000 p.s.i. hydraulic systems are provided. Each primary control surface is operated by three hydraulic jacks, adjacent to the surface and working in parallel. This arrangement means that any pair of jacks will overcome malfunctioning in the third, and any one will continue to operate the controls.

Three engine-driven pumps and an independent power supply are available for the hydraulic system. Electrical power supply consists of a 400-cycle 115/200-volt 3-phase constant AC system and a 28-volt DC system, the latter through transformer-rectifiers from the three generators.

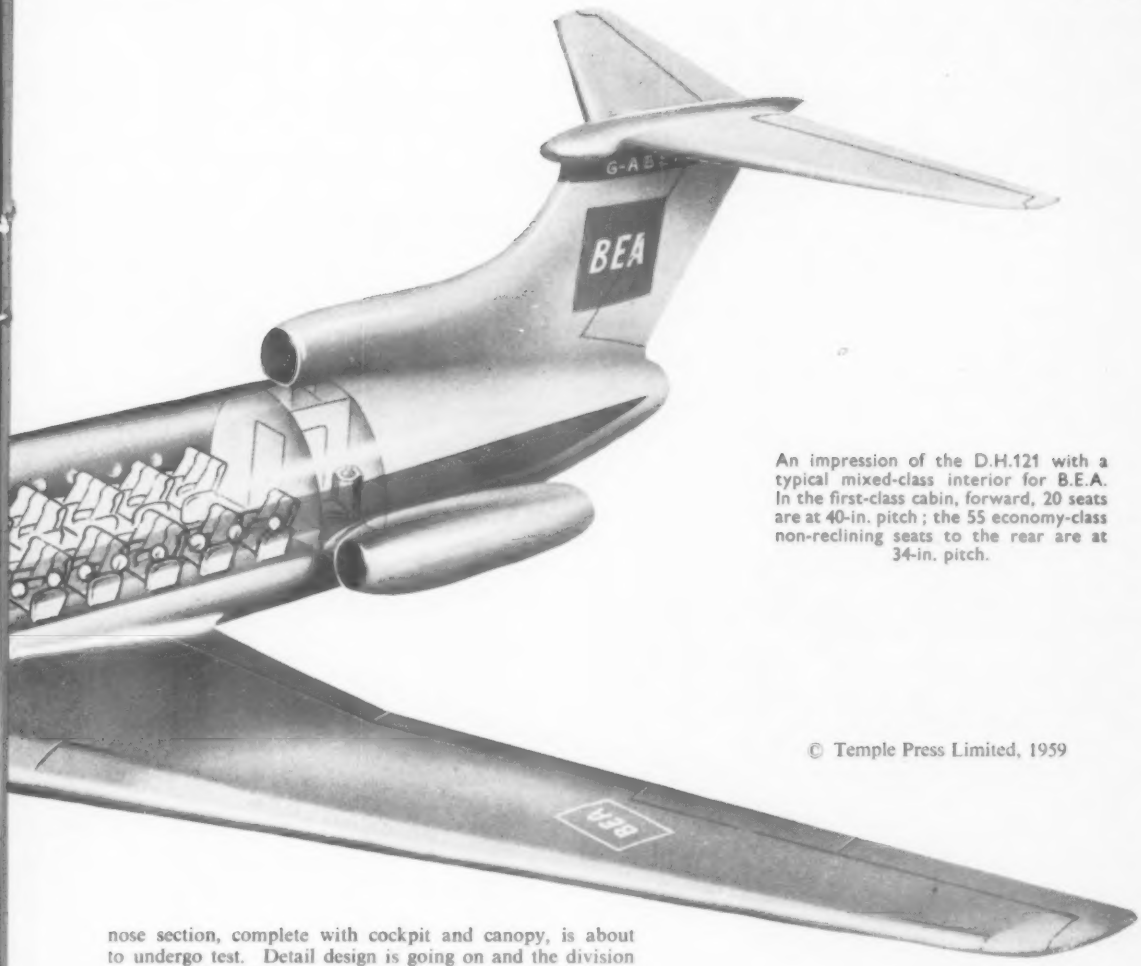
The D.H.121 is thought to be the first aeroplane designed from the start with full provision for automatic landing, as specified by B.E.A. Initially, the equipment will provide for automatic flare-out and touch-down through the autopilot, with automatic control of engine power down to the touch-down point. Later stages will be the addition of equipment to control roll and yaw below 200 ft. and to kick-off drift prior to touchdown.

Various layouts have been prepared for the D.H.121 cabin, which is roomy enough for six-abreast economy-class seating. The maximum will be 97 economy seats, although B.E.A. plan to use only 90. Typical mixed-class arrangements are B.E.A.'s 25 first and 50 economy, or 20 first and 55 economy. Provision has been made for airstairs, which will fold into the fuselage under the forward passenger door, and an auxiliary power unit can be fitted for engine starting and independent cabin air-conditioning.

Much wind-tunnel testing and some preliminary structural testing on the D.H.121 has been done already, and a fuselage



Take-off aerodrome lengths (B.C.A.R., 1959) assuming cost economical cruise at 32,000 ft.



An impression of the D.H.121 with a typical mixed-class interior for B.E.A. In the first-class cabin, forward, 20 seats are at 40-in. pitch; the 55 economy-class non-reclining seats to the rear are at 34-in. pitch.

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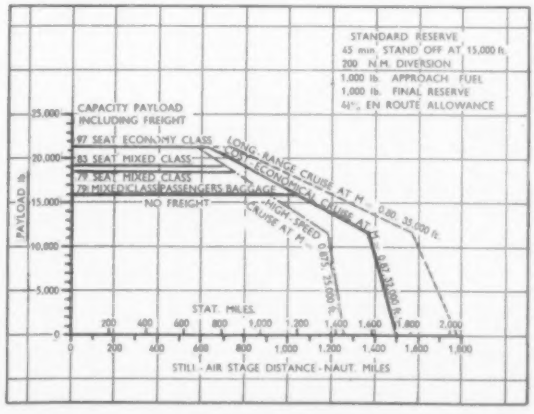
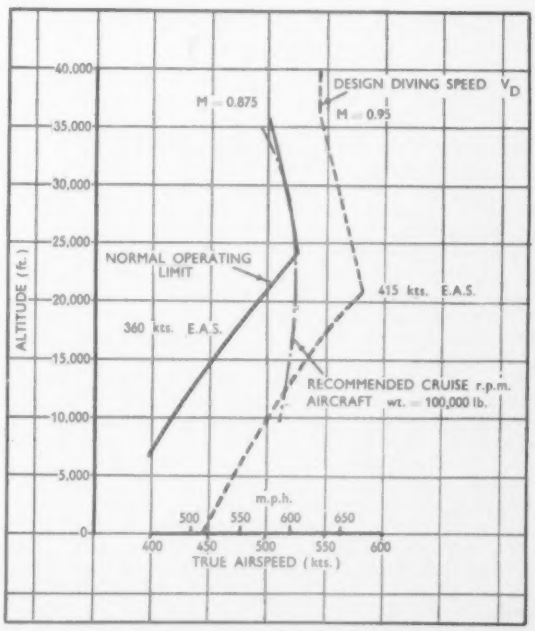
nose section, complete with cockpit and canopy, is about to undergo test. Detail design is going on and the division of responsibility between D.H., Hunting and Fairey has been agreed, teams from the last two having returned to their own offices after spending some time with de Havilland.

The first D.H.121 is expected to fly before the end of 1961, and Airco hope that orders will justify laying down an initial batch of 100 or so. This would mean that deliveries to B.E.A. and other customers could begin in quantity in the last quarter of 1963. The B.E.A. order for 24 will be delivered in three batches during 1963-1965, allowing earlier delivery to be offered to other customers and the B.E.A. fleet to be built up with increasing traffic.


STANDARD RESERVE
45 min. STAND OFF AT 15,000 ft.
200 N.M. DIVERSION
1,000 lb. APPROACH FUEL
1,000 lb. FINAL RESERVE
4½% EN ROUTE ALLOWANCE
CAPACITY PAYLOAD INCLUDING FREIGHT
97 SEAT ECONOMY CLASS
83 SEAT MIXED CLASS
79 SEAT MIXED CLASS
79 MIXED CLASS PASSENGERS BAGGAGE
NO FREIGHT
LONG-RANGE CRUISE AT M = 0.80, 35,000 ft.
COST-ECONOMICAL CRUISE AT M = 0.87, 35,000 ft.
HIGH-SPEED CRUISE AT M = 0.875, 35,000 ft.
0.80, 32,000 ft.
PAYLOAD lb.
STAT. MILES
STILL-AIR STAGE DISTANCE-NAUT. MILES

Payload-range curves for three cruising speeds, with fuel reserves as indicated, in I.S.A.



The speed capabilities of the D.H.121, in I.S.A. conditions. Cost economical speed is M = 0.87.

ON this page appears the first detailed cutaway drawing of the S.R.N.1. Hovercraft. This novel vehicle is propelled by air jets and supported at about 12 in. above ground level on a cushion of air which is kept at about 0.15 p.s.i. above atmospheric pressure. The air cushion is formed by inward-facing air jets around the outer edge of the craft; the theory of this lifting system is given at the end of this article.

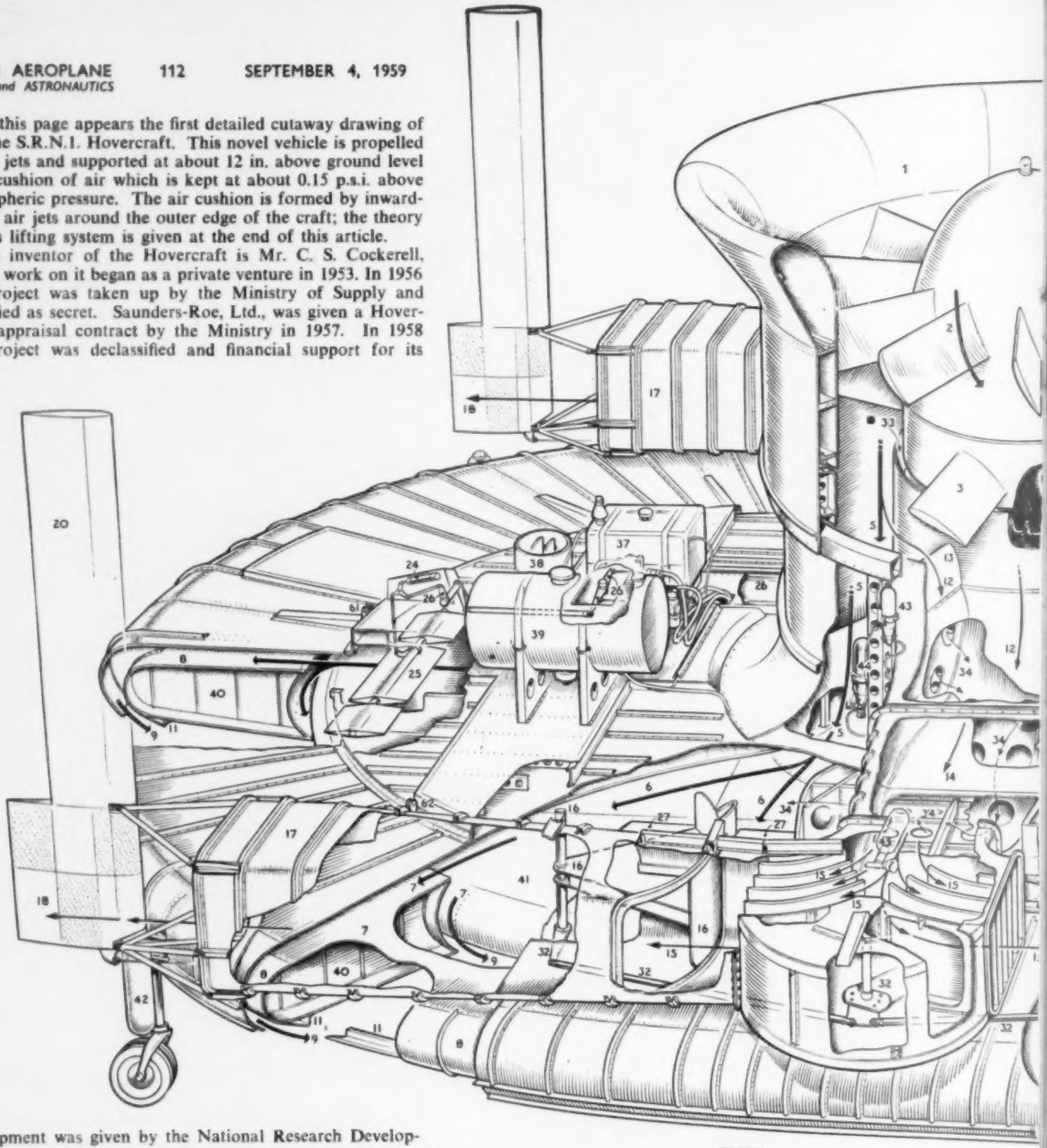
The inventor of the Hovercraft is Mr. C. S. Cockerell, whose work on it began as a private venture in 1953. In 1956 the project was taken up by the Ministry of Supply and classified as secret. Saunders-Roe, Ltd., was given a Hovercraft appraisal contract by the Ministry in 1957. In 1958 the project was declassified and financial support for its development was given by the National Research Development Corporation.

A company called Hovercraft Development, Ltd., was formed to control the project and Saunders-Roe was granted a further contract for work including the design and manufacture of a development vehicle, the S.R.N.1, which took the company less than eight months. Since its first tests this experimental prototype has been much in the public eye; one highlight was its crossing of the Channel on July 25. This took 2 hrs. 3 mins.; the average speed was about 13 kt.

The S.R.N.1 is powered by a 435-h.p. Alvis Leonides engine driving a four-bladed fixed-pitch axial fan which supplies air at about 16 p.s.i. for the lift curtains and for propulsion. About 70% of the power goes to the lift system and 30% to propulsion.

The lift system consists of two concentric air jets three feet apart, the outer one at the outer edge of the vehicle. The air jets are directed in towards the centre of the craft at 30° to the horizontal. A cushion of air is thus maintained under the craft to support it; the air curtains are deflected by this higher-pressure air cushion and travel outwards at ground level.

The S.R.N.1 was designed to operate 15 in. above ground level, although during tests this has not been achieved, and the actual hover height is just under 12 in.



KEY

CUSHION LIFT SYSTEM

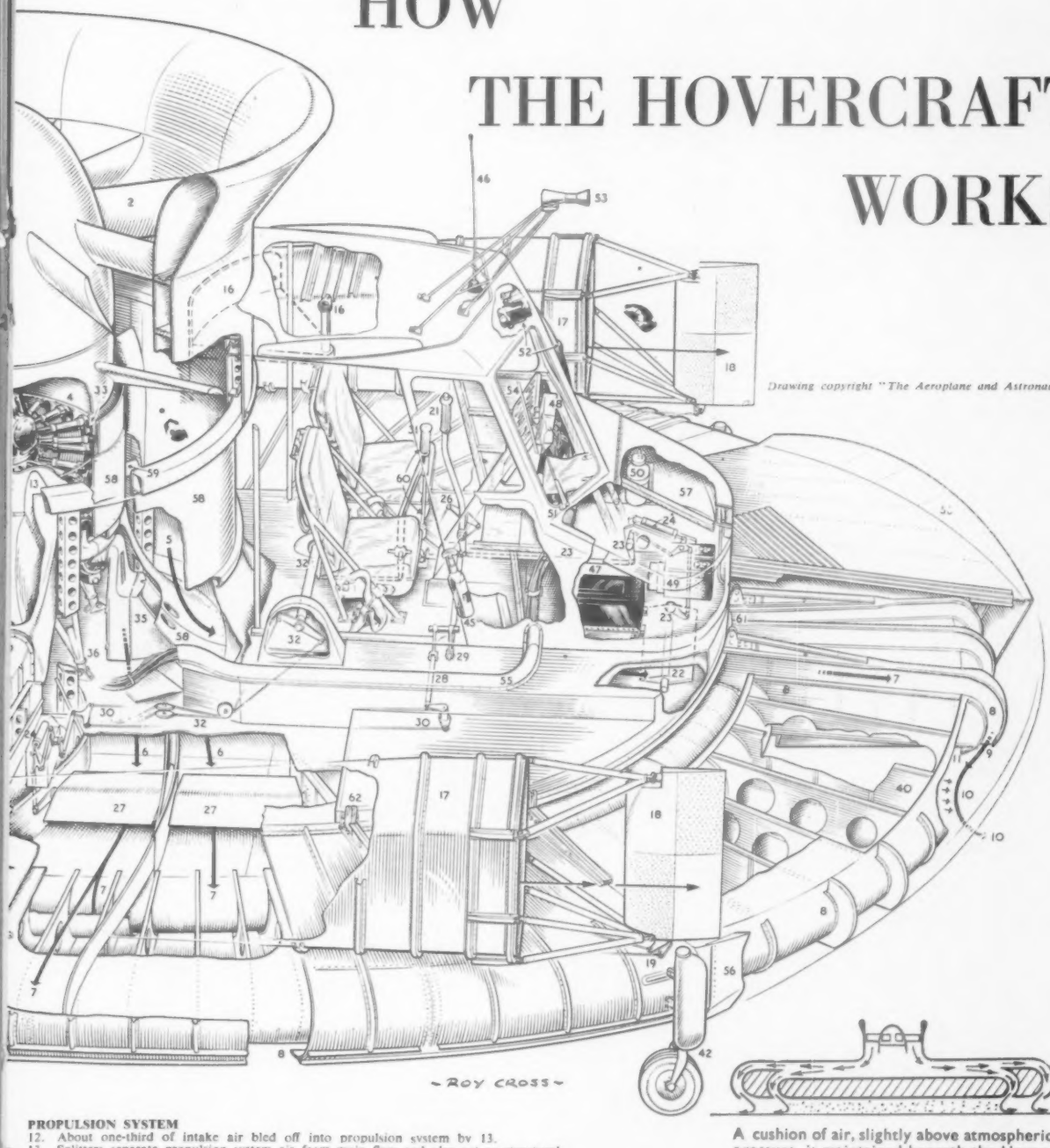
1. Main air intake.
2. Fixed guide vanes pre-spin air before it enters fan disc.
3. Four-bladed fixed-pitch Jicwood wooden fan (Leonides-driven, 7 ft. in diameter) pressurizes air for lift and propulsion systems. Airflow, pre-spun by guide vanes, is straightened again after passing through fan, preventing swirl in funnel.
4. 435 h.p. Alvis Leonides piston engine drives fan.
5. Roughly two-thirds of pressurized air passes down funnel into 6.
6. Main lift duct beneath top decking.
7. Air passes to inner and outer peripheral jet nozzles.
8. Jet nozzles, one spaced 3 ft. inboard of the other, continue completely round circumference of craft and face inwards at 30 degrees to the horizontal.
9. Air passing through nozzles creates air cushion beneath craft, giving lift.
10. Air jets are deflected and spill outwards because of air cushion pressure, creating doubled-walled air curtain which confines air cushion beneath craft.
11. Anti-Coanda effect wedge—prevents air jets sticking to bottom surface of craft.

Reaction propulsion is used for the Hovercraft; some 30% of the air which passes through the fan is exhausted through propulsion ducts to give thrust. The design operating speed is 25 kt.

The craft is 30 ft. long, 24 ft. wide and has an all-up weight of 7,500 lb.

The Hovercraft's pilot controls the vehicle via two sticks and rudder bars. The main control stick alters only the attitude of the craft; movements are made in the same way as with an aircraft control column to vary the attitude in pitch and roll. Movement of this stick operates valves in

HOW THE HOVERCRAFT WORKS



Drawing copyright "The Aeroplane and Astronautics"

A cushion of air, slightly above atmospheric pressure, is maintained beneath the Hovercraft by air jets around its periphery.

PROPULSION SYSTEM

12. About one-third of intake air bled off into propulsion system by 13.
13. Splitters separate propulsion system air from main flow and also act as structural stiffeners.
14. Air passes into propulsion ducts.
15. Guide vanes in propulsion duct direct air forwards and aft.
16. Pivoting gate-type propulsion duct valves, controlled from secondary stick.
17. Propulsion duct extensions.

DIRECTIONAL CONTROL

18. Rudders, operated from rudder bar, deflect jet stream for directional control.
19. Duplicated control levers on forward rudders carry cables to rear rudders.
20. Aerodynamic surfaces added to aft rudders.

PITCH CONTROL

21. Main stick, forward and backward movement of which gives pitch control. Forward movement shuts 22 front lift control valve (leaving rear valve open), via push-pull rod system 23. Lift curtain is spoiled locally, dropping nose.
24. Springs in rod control systems give feel and prevent valve overbalance.
25. Triple aft lift control valves, cable and rod operated (26), when closed by rearward stick movement spoil rear lift curtain locally, dropping stern.

ROLL CONTROL

Sideways movement of main stick gives roll control. For example, stick movement to right operates starboard lift duct valves 27 via control rods 28, hanging levers 29, and cables 30.

PROPULSION CONTROL

31. Secondary stick (push forward to close both front propulsion duct valves, directing full thrust aft and giving forward motion—pull back to give rearwards motion).
32. Linkage is via cockpit cross shaft, cables, and rods, to gate-type valves 16

GENERAL

33. Engine cooling air skimmed off here and passed through holes in ducts and top decking 34 to atmosphere.
35. Carburetter air intake with Vokes air filter.
36. Engine mounting feet bolted to fittings on buoyancy chamber.
37. Oil tank.
38. Oil cooler
39. Fuel tank (30 gal.).
40. Bulkheads divide structure into watertight compartments.
41. Buoyancy chamber, also divided into watertight compartments.
42. Beaching wheels (quickly detachable) with buoyancy chambers attached. Wheels interchangeable with landing pads.
43. 1 lb. fire extinguisher bottle for carburetter intake.
44. 6 lb. fire extinguisher for engine spray rings.
45. Hand extinguishers.
46. Whip aerial.
47. Pye VHF radiotelephone transmitter/receiver.
48. Radio control panel above dash. Intercomm. integral with radio circuit.
49. Battery.
50. Windscreen washer bottle.
51. Screen wiper.
52. Rotating clear view panel and motor.
53. A.s.i. venturi.
54. Main instrument panel.
55. Cable conduit.
56. Bow structure.
57. Equipment boot.
58. Inner and outer access panels to power unit, funnel, etc.
59. Engine exhaust pipe passes through splitter.
60. Throttle controlled from twistgrip on secondary stick.
61. Handling and towing lugs.
62. Hoisting lugs.

TRANS-CHANNEL TRIP.—Swathed in spray and trailing a foamy wake, the Hovercraft makes its first crossing of the English Channel at an average speed of 13 kt.

HOVERCRAFT CONTROLS.—The main control stick of the Hovercraft, between the pilot's legs, acts in the same way as an aircraft's control column to vary pitch and roll attitude. On the pilot's right is the secondary control stick which is moved backwards or forwards to propel the craft in the appropriate direction; the top of this column is formed by a twist-grip throttle control for the engine.

four lift-control ducts which are respectively at the front, rear and on either side of the craft.

The secondary stick is moved forward to give forward motion and backwards for rearward movement of the S.R.N.1. Movement of this control opens or closes valves in the propulsion ducts so that air is ejected in the appropriate direction. Rudder bars are used for yaw control; they vary the angle of deflector vanes at the ends of the propulsion ducts. The rear deflection vanes have vertical extensions which act as normal aerodynamic rudders.

Future Developments

The experimental S.R.N.1 is being modified for further practical tests of the Hovercraft principle. Modifications will include the installation of a second engine to increase the hover height to about 18 in. and operating speed to 40-50 kt.

Studies have been made of operational Hovercraft which, it is suggested, could be used as fast ferries for short sea crossings or as cross-country vehicles in roadless countries.

One of the projects is a 100-ton cross-channel passenger ferry which would cruise at about 90 kt., operating at a height of between 1 and 4 ft. above the water. It would be about 130 ft. long and would carry 300 passengers and their luggage, equivalent to a payload of 30 tons, or 30% of the laden weight.

Another project is a 400-ton long-range vehicle transport to cruise at 100 kt. over a 300 n.m. stage length. Its operating height would be between 3 and 8 ft. Such a vehicle would have both civil and military applications, as it could land well up a beach or slipway and make loading and unloading very simple. About 220 ft. long, it would have a 160-ton payload. This load, 40% of its all-up weight, is equivalent to 20 laden trucks, each weighing eight tons.

Another study is of a Hovercar which could operate at speeds up to 100 m.p.h. It would be 27 ft. long and have a laden weight of 4½ tons. Sixteen passengers or 1½ tons of freight could be carried. This Hovercar would be suitable for operation in remote areas of undeveloped countries. It would not need conventional roads and bridges, but merely an unmetalled trackway free from obstacles with perhaps shallow ramps at river banks.

Much development is obviously necessary before such projects come to fruition, but the Hovercraft principle would seem to have considerable potentialities. Operating height of the vehicles is limited if they are to be used economically and this will probably be the deciding factor in their future use.

Hovercraft Theory

In the Hovercraft concept of lift a jet of air forming a curtain is ejected towards the centre of the craft from all points of the craft around its circumference. The increase in pressure built up beneath the craft bends the air curtain so that it is ejected away from the centre of the craft in contact with the ground or water.

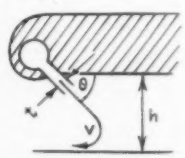
This system produces lift at zero incidence and forward speed. Consider the flow in a vertical plane of unit width of a thin air curtain and neglect second order effects.

Equating the rate of momentum change in the air curtain to the forces acting on the air curtain by the air cushion:

$$\rho V^2 t\,(1+\cos\theta) = p_c h \quad —(1)$$

where:—

V = curtain velocity
t = thickness of air curtain
Θ = initial angle of incidence relative to the horizontal
h = craft height
p_c = cushion pressure
ρ = air density



Now consider for the sake of simplicity a circular craft with curtain radius r.

Total thrust of the air curtain $T = 2\pi r \rho V^2 t$ —(2)

The weight of the craft W is given by $W = \pi r^2 p_c$ —(3)

Substituting equations (2) and (3) into equation (1):—

$$\frac{T\,(1+\cos\theta)}{2\pi r} = \frac{Wh}{\pi r^2}$$

$$\text{Hence} \quad \frac{W}{T} = \frac{r}{h}\,(1+\cos\theta) \quad —(4)$$

The maximum value of $(1+\cos\theta)$ occurs for jets which face horizontally inward; in this case there is no direct thrust contribution to the lift of the craft. From equation (4) it is seen that the value of weight over thrust is proportional to the radius of the craft divided by its height off the ground. Hence, for high efficiency the Hovercraft must be large in terms of its operating height.

Putting power requirements for lift $P = T \times V$ into equation (4)

$$\frac{P}{W} = \frac{V \times h}{r\,(1+\cos\theta)}$$

Hence for minimum power V must be as small as possible. The lower practical limit of V depends on the cushion pressure, the lower limit of which depends upon the velocity for which the craft is designed.

Farnborough Portfolio—3

THE AVRO 748 FEEDER LINER

Two 1,740 e.h.p. R.R. Dart R Da. 6 Mk. 514 turboprops

Dimensions
Span: 95 ft. 0 in.
Overall length: 67 ft. 0 in.
Overall height: 24 ft. 10½ in.
Gross wing area: 795 sq. ft.
Aspect ratio: 11.352.
Internal cabin dimensions:
Length (ex. flight deck): 46 ft. 6 in.
Max. width: 97.2 in.
Max. height: 76.6 in.
Max. useable floor area (less flight deck): 296 sq. ft.
Max. useable volume (ex. flight deck): 1,990 cu. ft.
Baggage and freight volume: 335 cu. ft.

Accommodation
Normal tourist: 36 (4 abreast).
Max. coach: 44 (4 abreast).

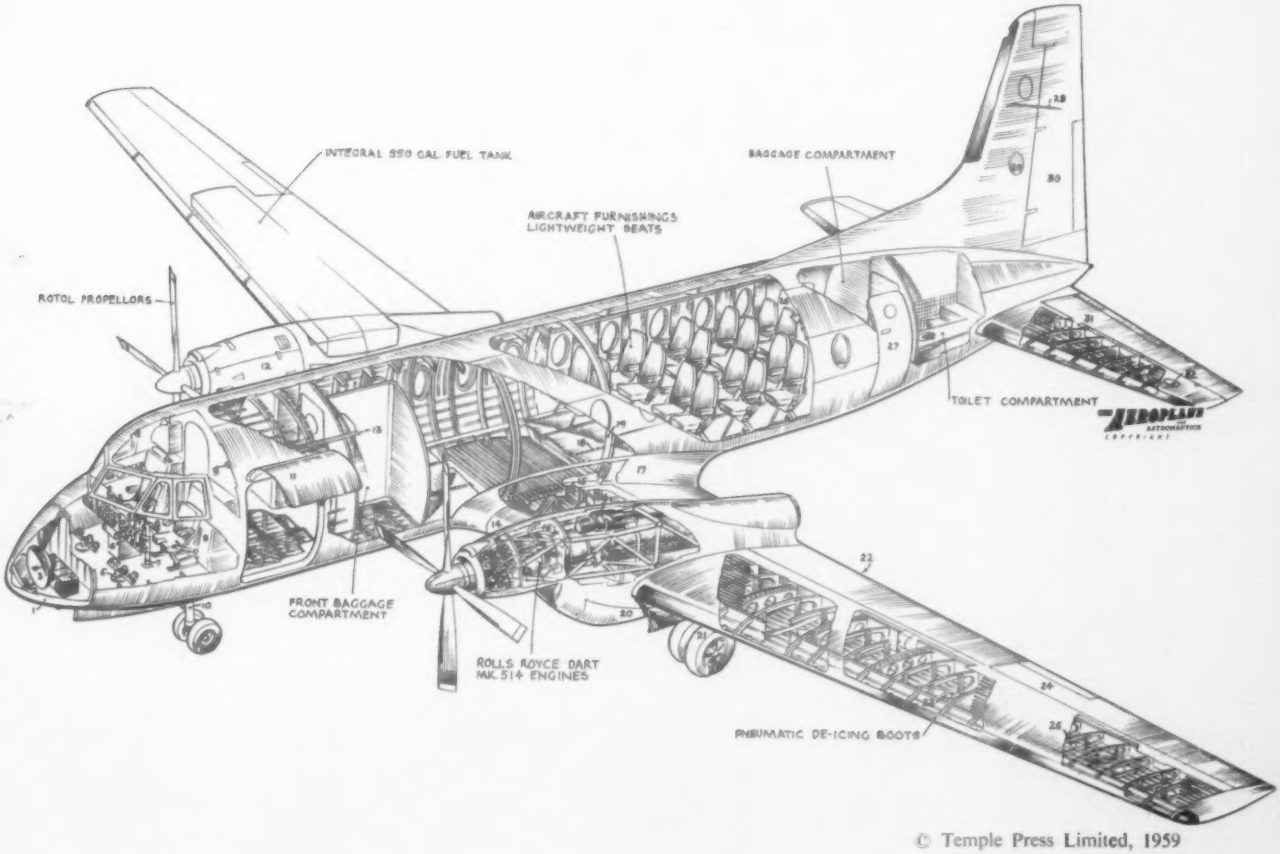
Powerplants
Two Rolls-Royce Dart R.Da.6 Mk. 514.
Take-off power each (I.S.A., s.l.): 1,740 e.h.p. at 14,500 r.p.m.
Rotol c.s., f.f., four-bladed propellers, 12 ft. diameter.

Weights and Loadings (40 pass.)
Basic operational: 19,444 lb.
Total fuel: 8,910 lb.
Mfrs. cap. payload: 9,666 lb.
Max. take-off: 33,000 lb.
Max. landing: 33,000 lb.
Max. zero fuel: 29,110 lb.
Wing loading (max. t-o. wt.): 41.5 lb./sq. ft.
Power loading (max. t-o. wt.): 9.5 lb./e.h.p.

Performance
Recommended cont. cruising speed (I.S.A.): 230 knots (at 20,000 ft. and 31,000 lb.); consumption, 0.675 lb./s.h.p./hr.
Balanced field lengths (max. t-o. wt.): I.S.A. (sea level): 3,500 ft.
I.S.A. +15° (sea level): 3,750 ft.
I.S.A. (5,000 ft.): 4,750 ft.
Landing field length (from 50 ft. at max. wt., I.S.A., s.l.): 2,310 ft.
Range (take-off to landing), still air, no reserves, I.S.A., max. fuel (1,100 Imp. gal.): 1,630 naut. mi. with 4,420 lb. payload at 230 knots (mean) at 20,000 ft. (mean).
Range (take-off to landing), still air, no reserves, I.S.A., with max. payload: 580 naut. mi.

KEY

1. Hinged nose-cap.
2. Glide-slope aerial.
3. Cloud-collision radar.
4. Batteries.
5. Rudder pedals.
6. Central control pedestal.
7. Control column.
8. Radio racks.
9. Air duct to cockpit.
10. Nose undercarriage (hydraulic operation).
11. Freight, and crew entry door.
12. Viscount-type powerplant.
13. Air duct to cabin.
14. Hinged leading edge.
15. Centre section to mainplane stringer joints.
16. Engine accessories gear-box.
17. Water-methanol tanks in wing root fillets.
18. Four-seat-attachment rails in floor.
19. Fuselage-centre section attachment frame (front and rear spars).
20. Main undercarriage wheel doors.
21. Main undercarriage (hydraulic operation).
22. Flap (electric operation).
23. Fuel filler.
24. Aileron.
25. Wing inspection panel.
26. Rear baggage door.
27. Cabin entry door.
28. ILS localizer and VOR aerial.
29. Fin inspection panel.
30. Rudder.
31. Elevator.
32. Tailplane inspection panel.



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Farnborough Portfolio—4

D.H. SEA VIXEN FAW. 1

ALL-WEATHER NAVAL FIGHTER

Two Rolls-Royce Avon 200 Series Turbojets

KEY

Front Fuselage, with pressurized cockpit picks up on centre-section at 12 and 13.

1. Glass-fibre radome. 2 locking-spigots, 3 radome lock lever and 4 hinge mechanism.
5. Nosewheel with retraction jack and 6 steering jack.
7. Fairing doors with deck-approach light and landing lights.
8. Wheel-well casing above cockpit floor, 9 pilot to port of it and navigator 10 to starboard.
11. Navigator's hatch.
12. 13 Fuselage connections to centre-section.
14. 15 Front and rear pressure bulkheads.
16. Pressure flooring with 17 controls through step.
18. Rocket-pack on each side of nosewheel with 19 underfloor operating jack.
20. Air-brake, hinged at 21 with 22 op. jack (note 23 deep central underfloor keel).
24. Wedged fairing fits into space between air-brake hinge-arms 25.
26. Sliding hood with rack and pinion and horizontal and vertical rollers running in trough 27 (jettisonable by explosive charge).

Centre Section comprising

28. Rib on aircraft centre line with 29 one open, braced bay.
30. Torsion box between main spars 30-30 (with 30a catapult launching hook).
31. Engine-bay detachable fire walls.
32. Spectacle-beam and jetpipe fairing.
33. Engine mounting trunnions (rear).
34. Engine forward mounting.
35. Arrester hook, hinge-point and jack.
36. Ram-air turbine drives emergency hydraulic pump for flying controls. ("Jack-in-the-box" stowage in jetpipe fairing.)
37. Hinged arm.
38. Down-lock hook keeps unit retracted into box against action of spring damper. If flying-control hydraulic pressure fails, manual release of down-lock hook extends unit into airstream to provide emergency hydraulic supply.
39. Capping strip and top cowling fasteners.
40. Floor structure (including 41 beam carrying underfloor auxiliaries-gearbox by trunnions); 42 drive from engine, 43 generator and other auxiliaries are seen. Drive under starboard bay floor from the same gearbox to a second set of auxiliaries.
44. Hydraulic filters in trough.
45. Undercarriage hinge bracket and 46 operating jack.

45a. Undercarriage hinge axis.

47. Radius rods and 48 connections to up-lock and 49 door operating servodyne.

Wing Fold

50. Centre-plane end rib with 51 wing-fold linkage and operating jack.
52. Fixed pivots of linkage 51.
53. Bracket on outer-wing.
54. Latch-pin operating jack (expands at both ends to 55, 56, 57) rocks arms to 58 open or close latch pins, plus 59 latch gear through 60 spring strut to give delayed action to pin 59. One end of jack 54 will be anchored when 61 cam plate is blocked by action from cockpit.
62. One of the outer-wing latches shown attached to 63 piece of outer-wing end-rib.
64. Two wing-fold hinge points.
65. Light-store pylon housing: 65a light-store pylons.
66. Heavy-store pylon housing (drop tanks or bombs can be carried).
67. Boundary-layer fence.

Aileron Control

From 68 stick (with 69 manual control to vary gear ratio) thence via 70 and cable-runs through step 1[illegible] to wing leading-edge, thence via 71 drive transfer mechanism (one half on centre-plane rib, the other half on outer-plane rib, halves press together against spring to form cable spring-tensioner) thence via 72 rod and swinging arms to 73 spring-feel unit with 74 its centring-plate and spring, thence to 75 dual-levers, centring strut and autopilot actuator and 76 operating jack.

77. Inductor transmitter between 73 and 75, on starboard aileron only.

RUDDER CONTROL

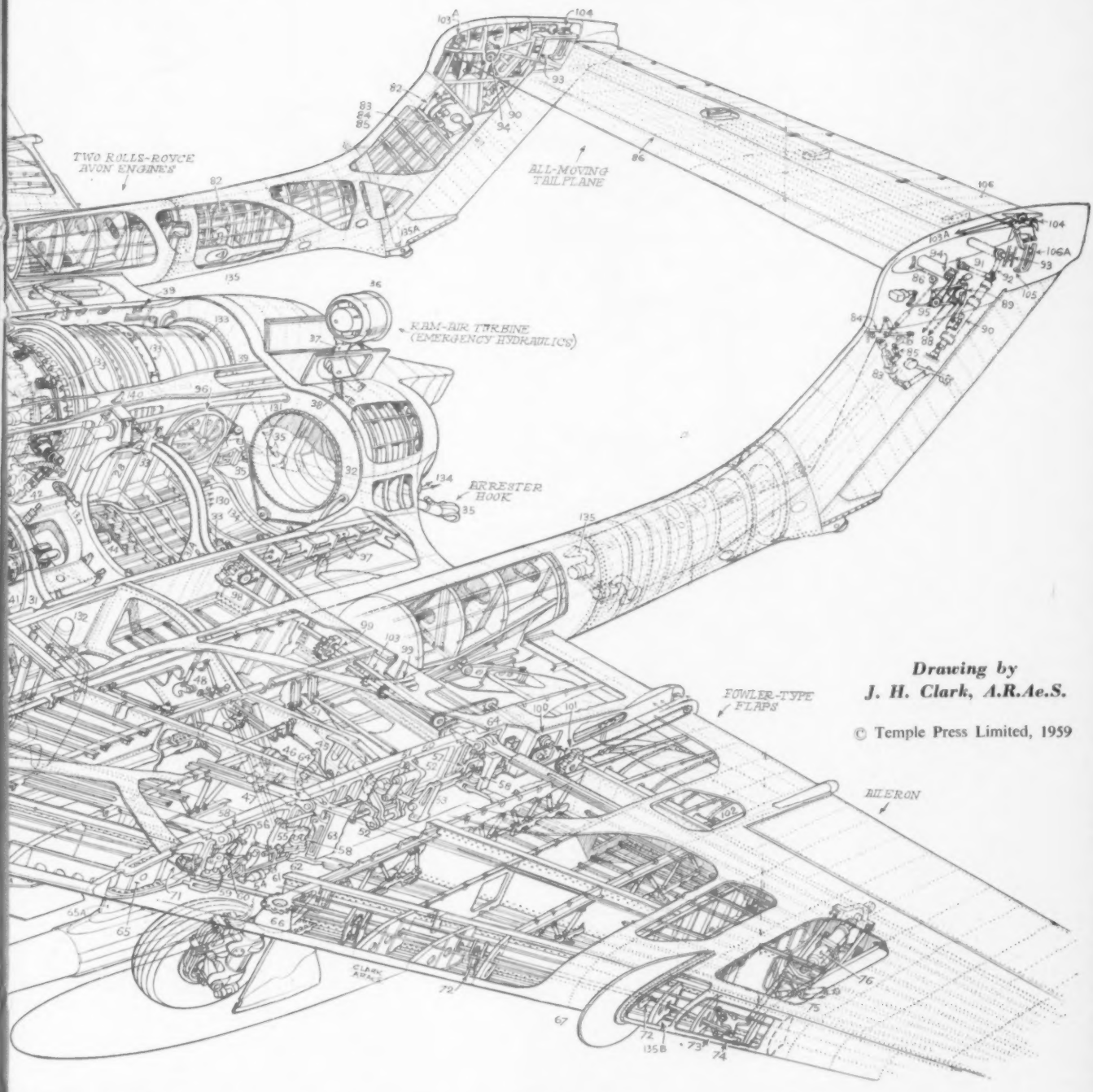
From 78 rudder pedals and cables through pressure glands at 17 (coupling-up to 79 sprocket drive on way).

79. Sprocket drive to 80 dashpot which is loaded by airspeed through 81 pressure head to give "q" feel on stick.
82. Cable drive from glands 17 up starboard tail-boom to 83 rudder control unit with 84 its spring-strut and 85 electrical autostabilizer actuator; thence via coupler cable up and across 86 tailplane front spar down to port fin unit[illegible] and down port boom back to cockpit.

ALL-MOVING TAILPLANE CONTROL

From 68 stick via 87 connecting-rod, g-restrictor mechanism 87a and cable glands 17 up tail boom as at 88 to 89 spring-feel cam, thence to 90 operating jack control valve.

Jack pushes upwards guided by 91 radius-rod



Drawing by
J. H. Clark, A.R.Ae.S.

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and 92 link to raise 93 tailplane in its guides and about 94 its axis. From 89 cam, rods pass back to 95 Mach-sensitive gear change. From 95 coupler cables up into 94 tailplane hinge shaft and across to other boom where layout is similar. Thence back down to cockpit.

FLAP CONTROL

96. From driving wheel in port engine bay (driven by jack alongside in starboard engine bay) thence via 97 cables to 98 gearbox and shafting. There are chain-drive take-offs to the flaps at 98, at either side of 99 tail boom, at 100 inner-wing end rib, at 101 outer-wing end rib (with coupler between) and at 102 outer end of outer-wing flap. All have guide tracks. At 99 they also have flap-tilting (torque) tracks.
103. Take-off from 103 flap-shaft up boom to 103a fin top. Thence along to 104 tailplane tab-track member hinged at 105 so as to displace the roller tracking 106a in it and the 106 moving-tailplane tab coupled to it (to give tail-down moment to counteract nose-down trim change when flaps selected " down ").

PRESSURIZING SYSTEM

107. Ram air in both sides under wings at root up to 108 heat exchangers (with 108a tapping to alternator cooling) thence to 109 pipe to 110 fan.
112. Meanwhile, hot air bleed from each engine at 15th compressor stage comes via 113 to exchanger 108 and up to 111 cold-air unit turbine. Mixture then on up to 114 water extractor.
113. Hot air also direct to 114 extractor via 115 temperature control valve.
114. Warm air mixture thence via 116 to cabin (canopy demist, punkah louvres, windscreen side panels demist).
116a. Three-channel duct (outer two demist rear canopy, middle demists front canopy).
117. From engine bleed 112 another branch 117 down to wing leading-edge light-store pylons 65 (with 118 heating-package for pneumatic system). 118a Ram air flow.
119. Branch-off from 118 passes straight through to cockpit for windscreen de-icing at 119 with 120 exhaust louvres.

AIR INTAKE DE-ICING

121. Gate valve, 15th stage engine air, thence via 122 to manifold 123 feeding jackets 124 around intake ducts and out through holes as at 125.
121a. Gate valve for de-icing intake of actual engine.
121b. Engine pressure-relief valve exhausts through cowling.
126. Extension to 123 feeds front intake as at 127 and boundary-layer air bleed facings. Same both sides, both engines.
127a. Boundary layer bleed outlet.
128. Duct beside 107 leads to generator (43) for cooling (same each side).

FIRE ZONES (A, 1 and 2)

A. From spar 30 to front firewall ring 31.
1. 31 to rear firewall 31a.
2. 31a to spectacle beam 32.

Ram-air exhaust from heat exchanger **108** and from fan 110 goes up and along 129 to empty into rear firewall. Some passes via louvres 130 into zone 2: remainder along pipe 131 and out aft. (Repeat other side.)

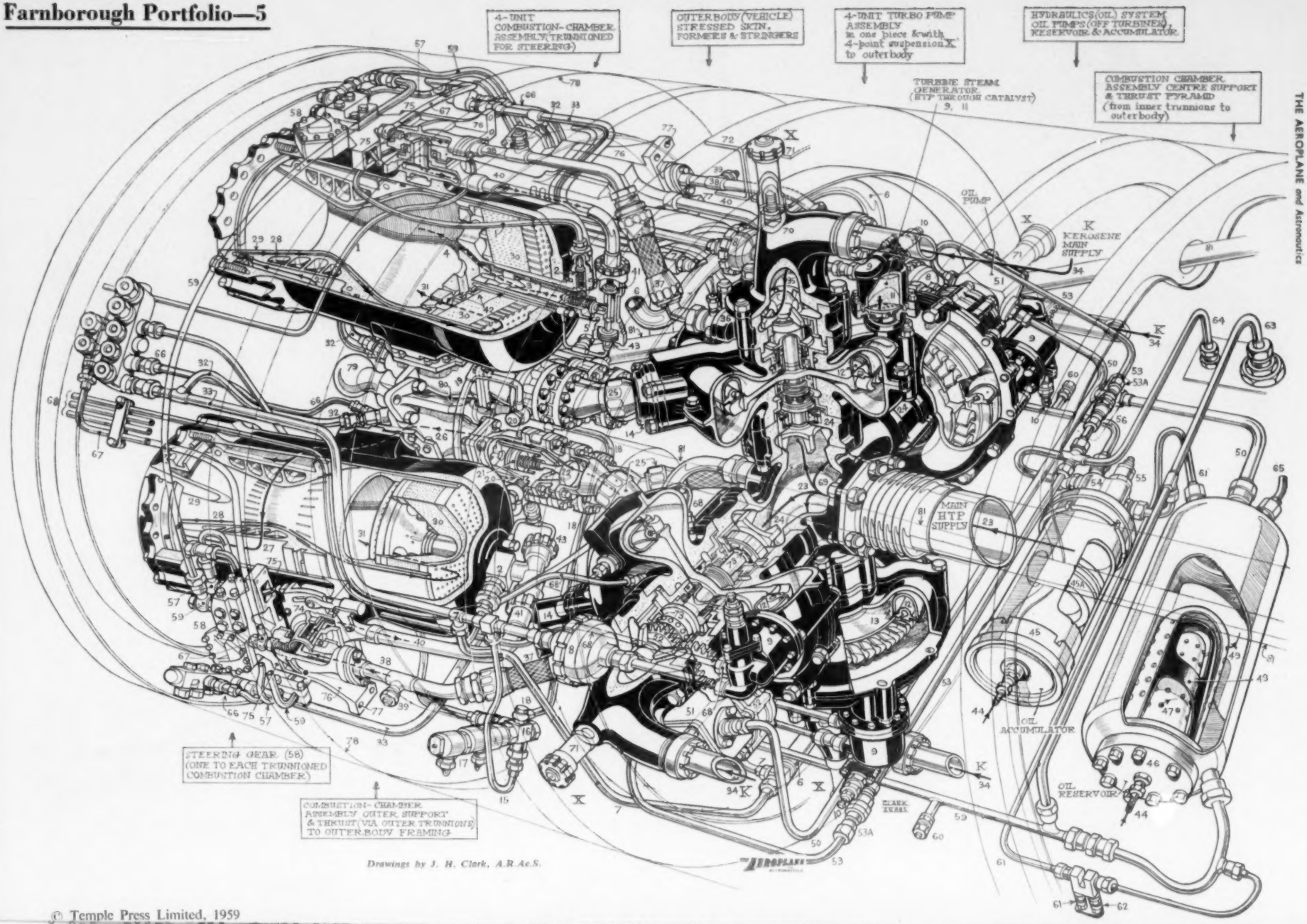
132. One 12 lb. fire-extinguisher (port and starboard undercarriage bays) and one 6 lb. bottle alongside duct 109 with spray nozzles in engine bays (zones A, 1 and 2).
133. Firewire fire-detection system around engines.
134. Engine wheelcase breather.
135. Invertors with cooling ducts.
135a. Tail-boom bumper and shock absorber.
135b. Drooping leading-edge profile outboard of fence.

RADIO AERIALS

136. TACAN (on fuselage nose).
137. TACAN (under fuselage by airbrake 20).
138. VHF (under fuselage nose).
139. IFF (under fuselage nose).
140. IFF (on centre rib of wing).

Two radio altimeters—on bottom skin line below **140**.

Farnborough Portfolio—5


4-UNIT COMBUSTION-CHAMBER ASSEMBLY (TRUNNIONED FOR STEERING)
OUTER BODY (VEHICLE) STRESSED SKIN, FORMERS & STRINGERS
4-UNIT TURBO PUMP ASSEMBLY in one piece &with 4-point suspension X to outer body
HYDRAULICS (OIL) SYSTEM, OIL PUMPS (OFF TURBINES), RESERVOIR & ACCUMULATOR.
COMBUSTION CHAMBER ASSEMBLY CENTRE SUPPORT & THRUST PYRAMID (from inner trunnions to outer body)
TURBINE STEAM GENERATOR (HTP THROUGH CATALYST)
OIL PUMP
KEROSENE MAIN SUPPLY
MAIN HTP SUPPLY
OIL ACCUMULATOR
OIL RESERVOIR
STEERING GEAR (58) (ONE TO EACH TRUNNIONED COMBUSTION CHAMBER)
COMBUSTION-CHAMBER ASSEMBLY OUTER SUPPORT & THRUST (VIA OUTER TRUNNIONS) TO OUTER BODY FRAMING
CLARK (PART)

Drawings by J. H. Clark, A.R.Ae.S.

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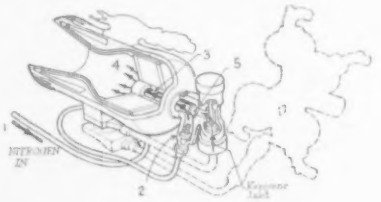
BRISTOL SIDDELEY GAMMA Mk. 201

This four-chamber rocket motor powers the Saunders-Roe Black Knight which in four successive firings at Woomera climbed to 250, 350 and twice to 500 miles. Its sea-level thrust is 16,400 lb., rising to nearly 19,000 lb. outside the atmosphere. Its propellents are kerosene and HTP.

NITROGEN CIRCUIT

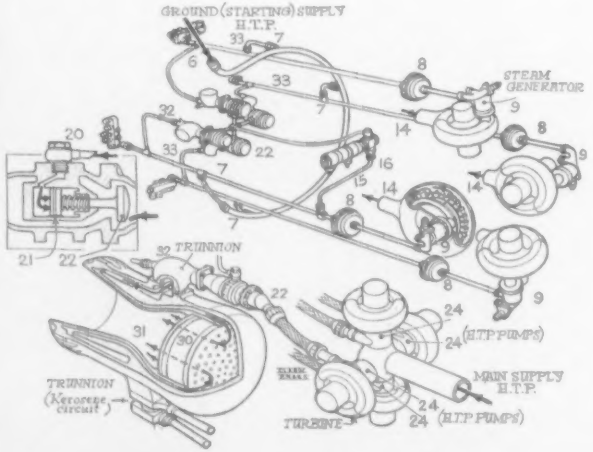
For engine starting nitrogen enters at 1, past non-return valve (2), down passage (3) and out through chamber at 4 to prevent flow-back of decomposed HTP into kerosene pipe past non-return valve (5).



HTP CIRCUIT

Ground-supply HTP passes through 6, out at 7, along through filter (8) to steam generator (9) with its safety valve (10). Through catalyst (11) to generate steam and oxygen mixture in nozzled duct (12) which impinges on turbine wheel (13) and exhausts at 14. Turbines are now running and driving HTP and kerosene pumps.

HTP also goes down 15 to stop-valve (16) which can be opened by hand-switched solenoid (17). Supply flows up 18, ring-main (19) in at 20 to



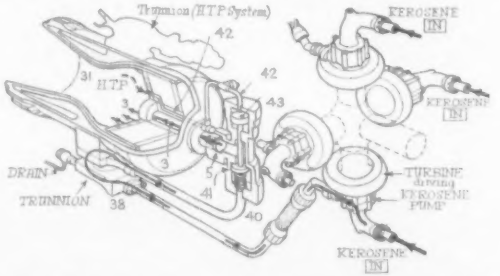
push piston (21) to open valve (22) which passes main HTP supply to combustion chamber.

Main HTP supply (23) from tank passes through pump (24) along flexible line (25) past 22, through central trunnion (26) along jacket (27) and back at 28 between jacket and its liner 29 and through catalyst (30) where it decomposes into steam and oxygen which enters chamber at 31.

HTP also leaves trunnion up 32 back along 33 through 8 and 9 to drive turbines and replace starting supply of HTP.

KEROSENE CIRCUIT

After pressure has built up in the HTP and kerosene pumps driven by the turbines (one for each combustion chamber), kerosene enters at 34 to pump (35) and out at 36, up flexible line (37), past adjustable orifice (39) along to outer-trunnion (38), through trunnion along 40 to valve (41) which is closed. Meanwhile some decomposed HTP in the combustion chamber has passed back



along bleed 42 to push piston 43 and to open spring-loaded valve (41). This ensures that decomposed HTP is in chamber at 31 before kerosene enters.

Kerosene now passes valve 41 and non-return valve (5) along passage 3 and into chamber. Fuel pressure closes 2 and prevents further nitrogen from entering passage 3. Decomposed HTP and kerosene meet and ignite; the rocket is now running.

HYDRAULIC SYSTEM

44. Nitrogen pressurizes accumulator (45) (with piston 45A) and reservoir (46).

47. Nitrogen out through inner guard to inflate rubber diaphragm 48.

49. Oil out through outer guard and reservoir at 50 to oil pump (51) (driven through gearing 52 off kerosene pump drive from turbine). Thence back via 53 and non-return valve 53A to accumulator (45) at 54 (with relief valve 55) and via 56 to ring-main (57) to feed each of the four chamber-swivelling actuators (58).

59. Oil return to reservoir (46).

60. Pressure tappings.

61. Oil-filling circuit.

62. Air bleed.

63 and 64. Ground return and in inlet connections for swivelling combustion chamber when engine is not running.

65. To thermal relief valve.

DRAINING SYSTEM

Hot air is blown right through HTP circuit from tank with stop valve (22) held open by compressed air; it is also blown through HTP starting line 6, 7, etc., to trunnions (26) with first hot air bleed (66), through chamber and out. Then mouth of chamber is blocked and remainder of hot air flows back to steam generator through turbine and out through exhaust (14).

67. Kerosene drain (on outer trunnions).

68. Three open drains to each turbine unit—the two pumps and control valve of steam generator (9).

MOUNTING DETAILS

69. Centre four-armed piece passes HTP (23) to pumps and forms the centre-piece of a four-armed mechanical structure containing pumps and turbines which is pegged to the vehicle outer body at four points (70).

71. Locator (part of outerbody attached to framing 72).

73. Ball-bearing to kerosene pumps; special polythene bearing to HTP pumps.

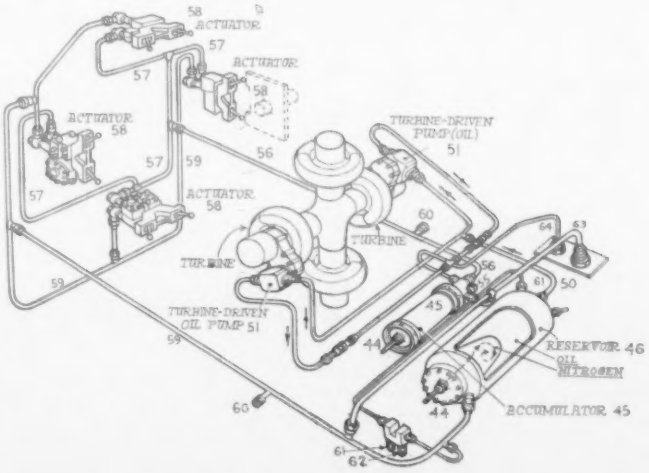
74. Plate carries outer trunnion spindle and is fixed to combustion chamber.

75. Two ball-ended arms actuated hydraulically move in and out of body 58 to rock plate 74 and combustion chamber. Chambers are trunnioned to splay out from the rocket centre-line in normal position and are pivoted to move tangential to the periphery.

76. Outer trunnion carries plate (74) in ball bearings and is fixed at 77 to former frame (78).

79. Ball end of tripod; this rests in launching-pad socket.

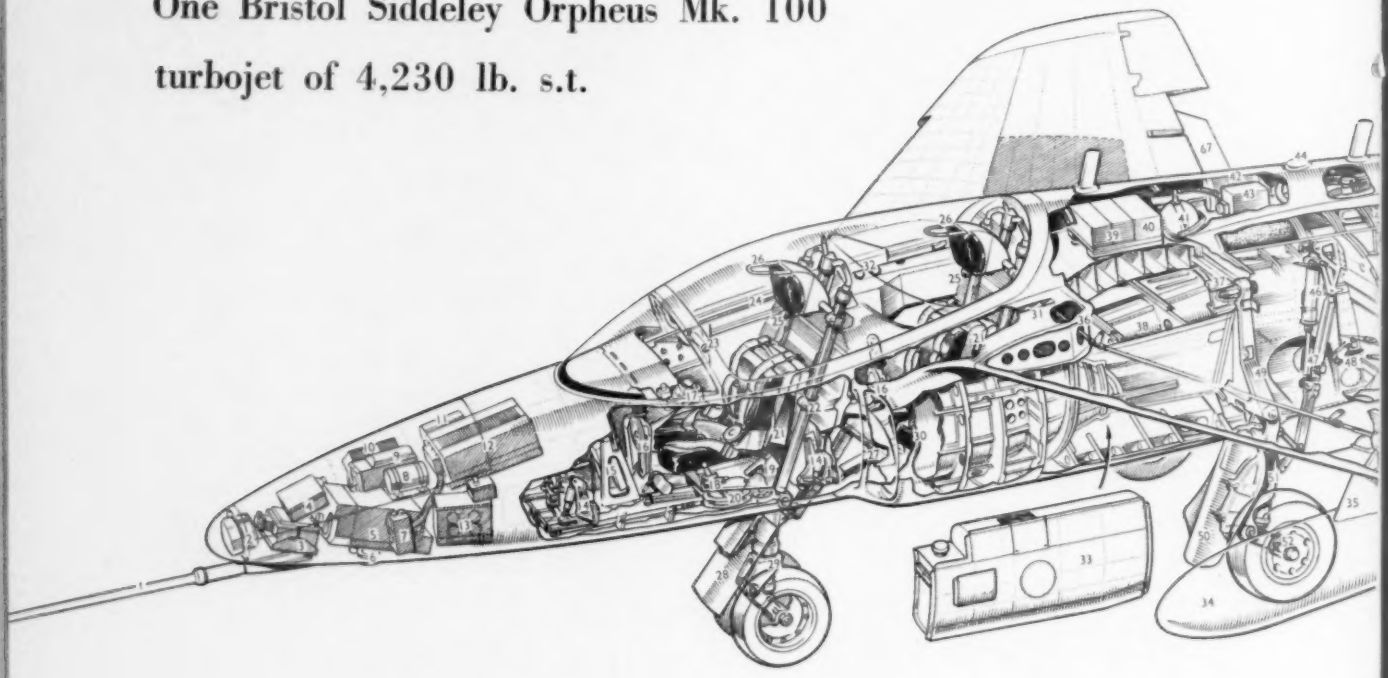
80. Pick-up lug and holes between each pair of inner trunnions for pyramid struts (81).



Farnborough Portfolio—6

FOLLAND GNAT TRAINER Mk. 1

One Bristol Siddeley Orpheus Mk. 100 turbojet of 4,230 lb. s.t.



A PRE-PRODUCTION batch of fourteen Mk. 1 Gnat Trainers is being built by Follands for the Royal Air Force. The first of these advanced trainers is now nearly complete and its constructors hope to have it at the S.B.A.C. Show.

The performance of the Trainer is similar to that of the Mk. 1 Gnat fighter. Its maximum level speed approaches Mach 1 so that fairly shallow dives produce supersonic speeds and allow pupils to experience transonic phenomena. This maximum speed is Mach 0.97 at the tropopause and over Mach 0.9 at sea level. Dives up to Mach 1.15 should be made quite easily.

To allow the "classroom" to be reached easily, a good rate of climb is needed so that most of the flying time can be spent at high altitude if necessary. The Gnat Trainer climbs to 40,000 ft. in about seven minutes, and has a ceiling above 50,000 ft.

All-weather operation is specified from 6,000-ft. runways; this gives rise to fairly severe low-speed handling requirements for an aircraft of this type. A typical training sortie one hour long can be flown; a sortie can be extended to two hours if overload fuel is carried in drop tanks.

The take-off and landing distances and speeds specified for the Trainer have led to the use of a larger wing than on the Gnat fighter and conventional split flaps have been fitted. Wing area is 175 sq. ft., nearly 40 sq. ft. more than that of the Mk. 1 fighter and nearly 100 gal. of fuel is carried in integral tanks. The inboard ailerons of the Gnat fighter have been replaced by conventional outboard ailerons. To offset drag produced by its increased area, the wing's thickness/chord ratio has been reduced from 8 to 7%. The larger wing and flaps have led to increases in tailplane and fin area.

The flying controls of the Gnat Trainer are fully powered with the exception of the rudder; the controls revert to manual if there is a power failure; this is possible because the aircraft is small. To allow recovery from any unusual manœuvre which the aircraft may be performing when a power failure occurs, a standby accumulator in each control system provides sufficient hydraulic fluid for recovery. Both the aileron and longitudinal control employ non-linear gearing to avoid oversensitivity during certain flight conditions.

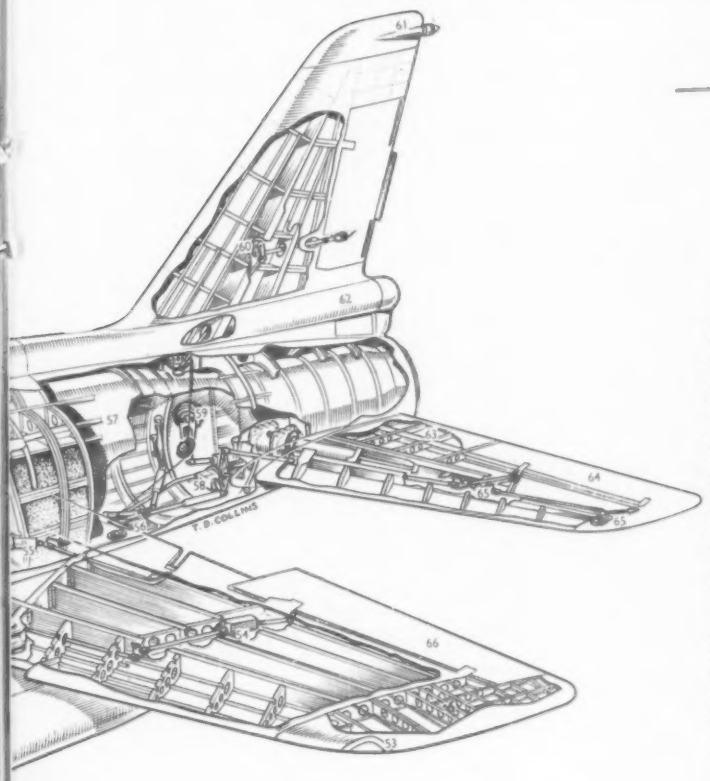
Longitudinal control is basically similar to that of the Gnat Mk. 1 system: the elevators are normally mechanically locked to the tailplanes to form a slab tail driven by a Hobson actuator. Following a hydraulic failure the elevators are unlocked and operated manually through cables and push-rods. The ailerons are powered by Lockheed servodynes and revert to manual control automatically.

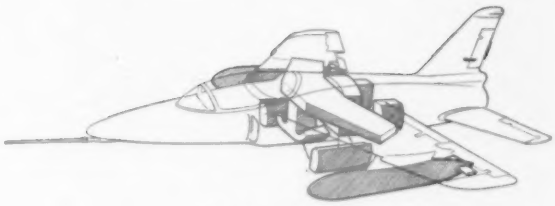
Powerplant is the Bristol Siddeley Orpheus Mk. 100 turbojet, rated at 4,230 lb. static thrust. This has a larger turbine than the Mk. 701 Orpheus and gives improved specific fuel consumption with only a slight compromise in performance. Low-pressure air starting is used.

The internal fuel tankage of 260 gal. gives the aircraft a maximum endurance of nearly two hours, or just under three hours when two 66-gal. drop tanks are carried.

The fuselage of the Trainer differs only in detail from that of the Gnat fighter. Many components are common to both aircraft, including about 40% of the few castings used. As with the fighter, the main and nose undercarriage legs retract rearwards into the fuselage and act as air brakes when partially extended.

Pupil and instructor sit in tandem. The instructor's cockpit is behind the point where the pressure bulkhead came





Fuel-tank layout

KEY

1. Pitôt head.
2. Landing lamp.
3. Main battery.
4. Standby battery.
5. Tacan transmitter/receiver.
6. Undercarriage external indicator lamp.
7. UHF junction box.
8. Standby artificial-horizon inverter-unit.
9. Compass gyro.
10. Altimeter amplifiers.
11. Standby artificial-horizon and direction-indicator control inverter unit.
12. UHF main and standby transmitter/receiver.
13. Tacan coupling unit.
14. Rudder bar complete with toe-operated wheel-brake pumps.
15. Oxygen regulator and UHF controller.
16. Control column.
17. Starboard console.
18. Harness control lever.
19. Manual override control.
20. Flying-control pulleys under floor.
21. Folland ejector seat.
22. Ejector-seat guide brackets.
23. Canopy control handle.
24. Air conditioning system.
25. Safety lock for ejector seat.
26. Ejector-seat firing-handle.
27. Undercarriage jack.
28. Undercarriage doors act as air brake.
29. Nose wheel.
30. Intake boundary-layer bleed duct.
31. Boundary-layer bleed outlet.
32. Starboard fairing pressure bungs.
33. Fuel tank.
34. Jettisonable fuel tank.
35. Pylon.
36. Forward wing attachments (port).
37. Rear wing attachments (port).
38. Bifurcated intakes.
39. ILS receivers.
40. Zero-reader computer.
41. Liquid-oxygen converter.
42. Water separator.
43. Voltage regulator.
44. Ground signalling light.
45. Engine-oil tank.
46. Main undercarriage jack.
47. Main undercarriage down-lock.
48. Main undercarriage up-lock.
49. Main undercarriage and wing attachment bracket.
50. Main undercarriage doors act as air brakes.
51. Main undercarriage.
52. Hydraulic wheel brakes.
53. Navigation light.
54. Aileron servo.
55. Flap servo.
56. Tail plane and elevator control quadrant.
57. Bristol Orpheus Mk. 100 engine.
58. Hobson control unit for slab tail.
59. Tailplane operating arm (starboard).
60. Rudder operating lever.
61. Navigation light.
62. Brake parachute.
63. Elevators locked to form slab tailplane which is power operated. If power fails elevators are unlocked and operated manually.
64. Elevator.
65. Elevator locks.
66. Ailerons.
67. Flaps in down position.

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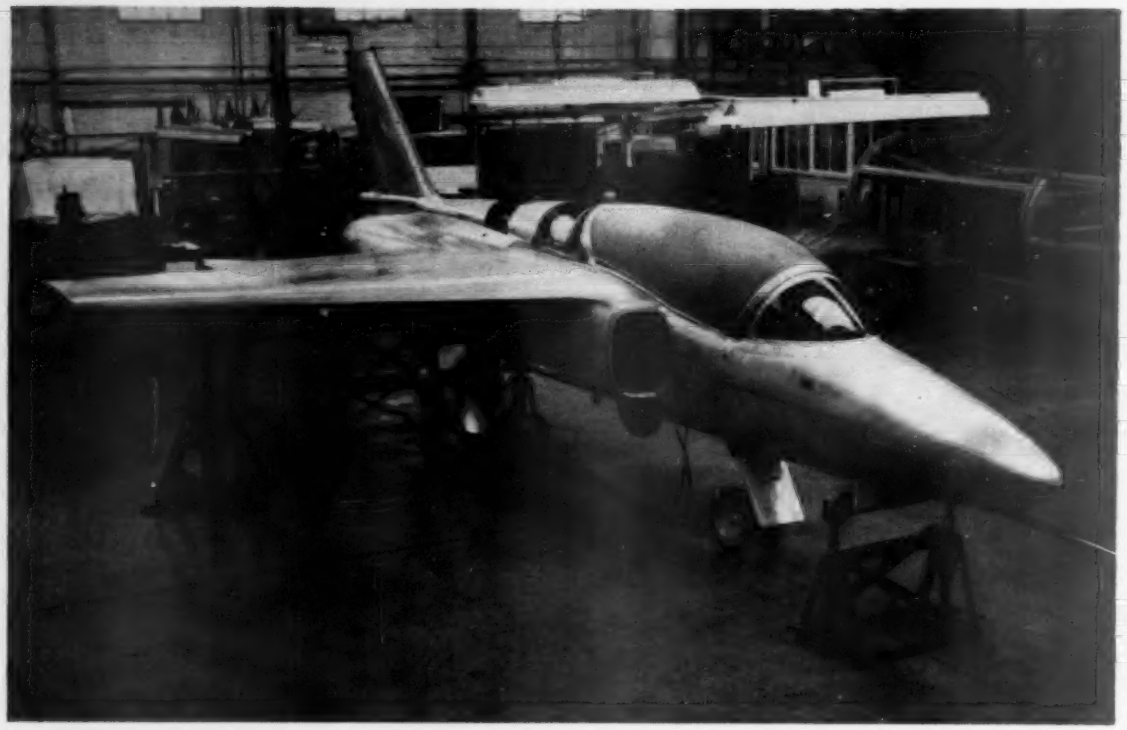
on the Gnat Mk. 1 and the fuselage has been lengthened by about nine inches here to provide a roomy cockpit. An equipment bay and a fuel tank, which were in this position fighter on the Mk. 1, have been re-sited—the fuel in the intake fairings in place of the discarded Aden cannon and ammunition tanks, and the equipment in the nose.

The latest Folland ejector seat will be fitted to the Mk. 1 Trainer. It will have an ejection velocity of approximately 80 ft./sec. and runway-level ejection will be possible. A combined release system is fitted, with the canopy and seat interconnected, but ejection through the canopy will also be possible.

When the Gnat 1 fighter was designed no fatigue life was specified for its structure. In the case of the Gnat Trainer a minimum fatigue life of ten years has been specified; it is based on R.A.F. training schedules for the types of operation and number of flying hours. Detail design of the Trainer to achieve this fatigue life—which is 5,000 hr.—will be backed up by an extensive test programme of a complete airframe to establish that a realistic life has been achieved.

Trainer Development

A Mk. 2 Gnat Trainer with a level speed of Mach 1.5 is in the preliminary design stage. A supersonic Mk. 2 fighter has been studied and a 6% thick wing for it has been built. Although the Mk. 1 Trainer wing is only 7% thick, as already mentioned, its area is 30% greater than the fighter wing to hold take-off and landing speeds and distances down to R.A.F. requirements. This prevents any worthwhile supersonic speeds being attained even with foreseeable engine developments. If a supersonic Gnat Trainer is to keep up in the next decade with the trend in aircraft speeds, it must have a thinner and smaller wing than that of the present Trainer. This can be produced relatively easily because the Gnat's wing is structurally very simple and only conservative high-lift devices have been used so



FIRST OF FOURTEEN.—Nearing completion at Follands' Hamble works is the first of fourteen Gnat Trainers for the R.A.F.

far—drooping ailerons-cum-flaps on the fighter and simple plain flaps and outboard ailerons on the trainer.

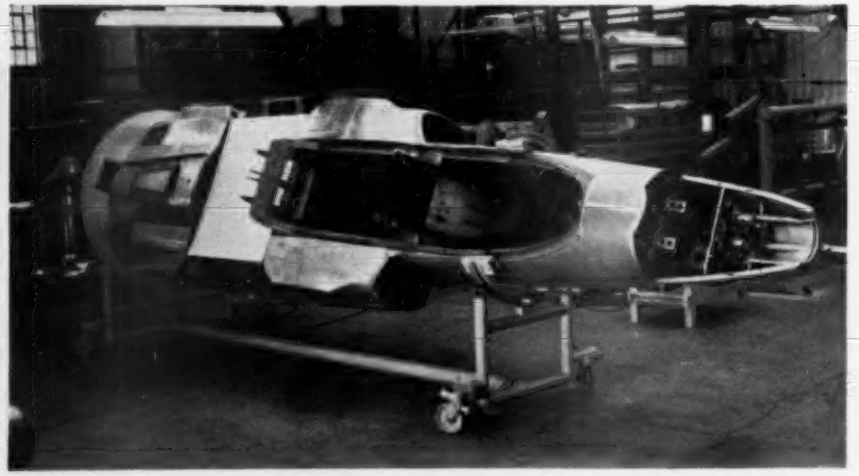
A thinner wing of intermediate area would be suitable for several Gnat developments if its lift at low speeds were no less than that of the present Trainer wing. It would be about 150-160 sq. ft. in area and 5% thick. It would have no more supersonic drag than the wing previously intended for supersonic Gnats, while full-span leading-edge and trailing-edge flaps, and a more advanced lateral-control system, would maintain the low stalling speeds needed for both trainer and naval carrier-borne fighter versions.

Engine reheat is the other essential for supersonic level speeds. Its installation in the Gnat requires a slightly larger rear fuselage, but the general design would be similar to the present one.

Thus, by taking a wing from a common production line for all Gnat variants (both subsonic and supersonic) and mating it with the present front and centre of the Trainer fuselage, and taking an engine and rear fuselage from the Mk. 2 fighter, a trainer could be produced which would be competitive with any known project.

Performance would be much better than that of the Mk. 1 Trainer. For less than a 10% increase in weight and little change in landing speed, there would be an increase in level speed of 50%. The aircraft would reach 50,000 ft. in about three and a half minutes from brakes off—less than half the time that present-day advanced trainers take to reach 30,000 ft.—while retaining ranges and endurances similar to those of the Mk. 1 Trainer. The airframe is capable of dealing with the increased thrust and Mach numbers from developed versions of engines now running, and the Gnat will always tend to have a height advantage with a given engine because of its lower weight and wing-loading.

Mk. 1 Gnat Trainer Details: Wingspan, 24 ft.; length, 30 ft. 9 in.; height, 9 ft. 7¼ in.; powerplant, Bristol Siddeley Orpheus Mk. 100; max. level speed, Mach 0.97; absolute ceiling, above 50,000 ft.; take-off distance to 50 ft., 850 yd.; landing distance from 50 ft., 1,300 yd. (wet runway); max. endurance, approximately 3 hr.



TANDEM TWO-SEATER.—In the Gnat Trainer the instructor and his pupil sit in tandem.

Farnborough Portfolio—7

Fan Lift by Boulton Paul

WHILE direct jet lift has, so far, been the only method mentioned in connection with British VTOL aircraft other than helicopters, forms of fan lift are also being studied. Boulton Paul, for example, have a Ministry of Supply contract for a detailed investigation and have done a considerable amount of work in this direction.

An indication of this is, in fact, to be seen on the company's stand at Farnborough. And although the unit disclosed is undoubtedly an early example, it is interesting as the first British device of this sort to be revealed in detail.

The Boulton Paul VTOL control fan shown is of the integral turbine-driven type using compressed air tapped from the compressor of the propulsive engine. In this sense it is a "cold" unit as opposed to a "hot" turbo-fan driven by the exhaust gases or by special combustion chambers. Essentially it is a ducted fan whose thrust can be varied rapidly over a wide range to provide lift and control.

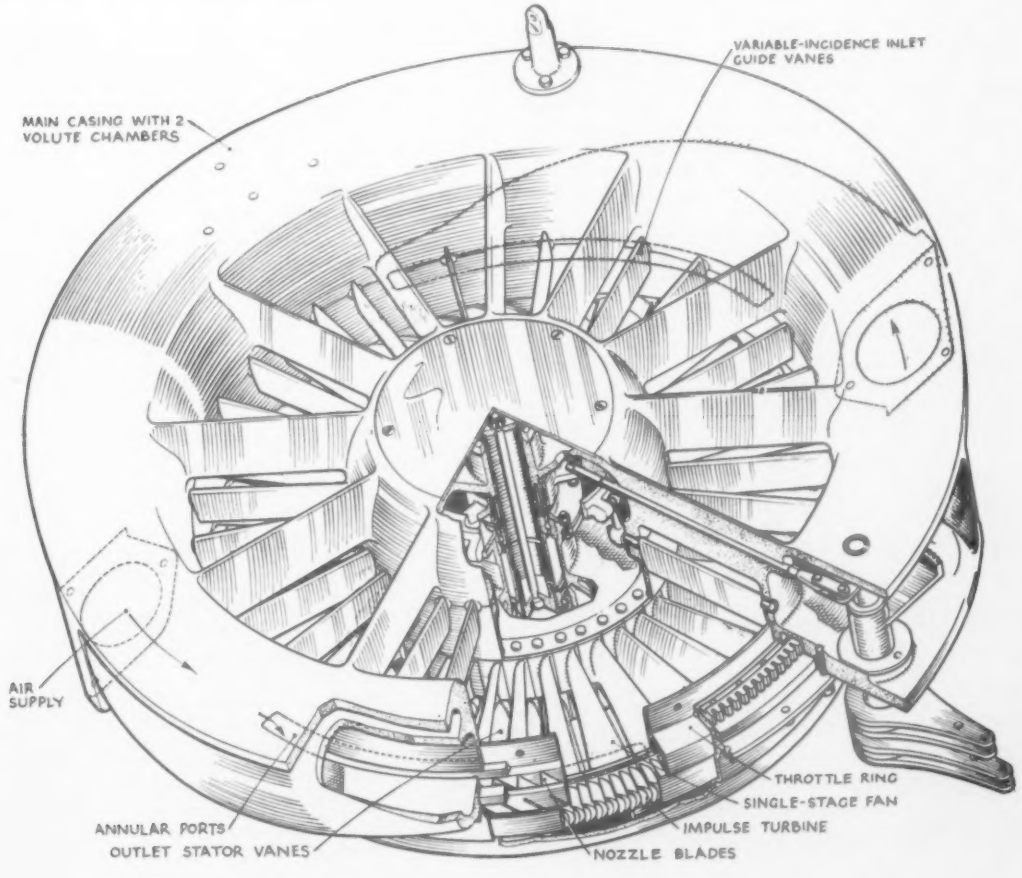
It has been designed specifically for mounting within the aircraft's wing structure and has its rotational axis vertical. And it is intended to give an immediately variable thrust of ±150 lb. about a mean 550 lb. at 6,000 r.p.m.

The unit comprises a single-stage axial fan with 42 blades, each having a T-flanged tip on which are located five integral turbine buckets. This 210-bladed turbine wheel is powered by air taken into the unit from two supply pipe inlets on opposite sides of the main casing. These lead to volute chambers within the casing and these in turn lead to two annular ports each subtending a 74.5° arc from which the air is expanded through turbine nozzles. These supersonic nozzles accelerate the air before it exhausts through the impulse-type turbine—the pressure drop taking place exclusively through the nozzles.

Air flow to the turbine is controlled by a throttle ring which can be moved to open or close the nozzles. This ring is rotated by a rack and pinion quadrant operated by an electric actuator.

The main fan blades are twisted to give a uniform axial velocity to the air flow. When this unit is rotated air flow is induced through the fan duct and the direction of the flow relative to the rotor blades is controlled by variable incidence guide vanes. These are interconnected within the fan hub and are controlled by a master vane linked at its outer end to the mechanism controlling the throttle ring.

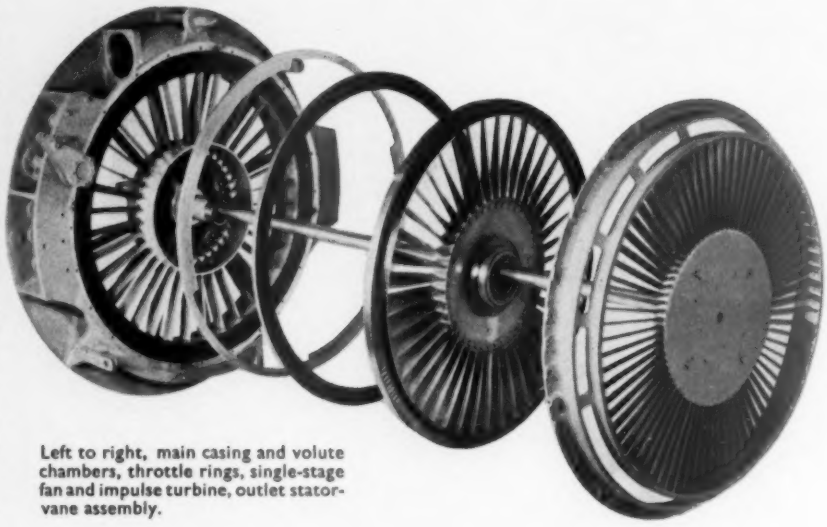
By this means, the amount of swirl imparted to the induced air flow before it passes through the fan is associated with the air supply to the power turbine. In consequence,



the power supply is varied in accordance with the work being done by the fan and rapid changes of thrust are obtained without changes in fan speed. Thus there are no rotor inertia effects introducing time lags in the control system.

Below the fan there are outlet stator vanes through which the efflux passes to atmosphere. Lubrication of this unit is by a total loss system, oil being admitted to the hollow central spindle and thence by drillings to the rotor bearings. The entire unit is made of light alloy—the main casings, for example, are magnesium alloy castings—and weighs 52 lb.

A fan of this type using compressor-bleed air will control a VTOL aircraft more economically than a simple control nozzle because for a given air consumption it produces a greater lift. It is also not so noisy.



Left to right, main casing and volute chambers, throttle rings, single-stage fan and impulse turbine, outlet stator-vane assembly.

Farnborough Portfolio—8

New Mass-flow Meter by A.W.E.

WITH the high fuel consumption of turbojet engines, the need to measure very accurately the rate at which fuel is being used in flight is of paramount importance.

Measurement of fuel flow by existing volumetric methods does not take into consideration variations in fuel density which occur between various batches of fuel and at varying temperatures. Fuel density at a particular temperature may vary by ±3% and variations due to temperature change from −40° C. to +40° C. will be approximately 8%. These errors will be of even greater importance in the future when more sophisticated automatic engine-control systems are introduced.

In this context, a new unit being developed by Armstrong Whitworth Equipment (previously Gloster's Technical Developments Division) and on show on the Hawker Siddeley stand at Farnborough, is of particular interest, for it appears to offer a means whereby fuel mass flow can be measured to within 1%.

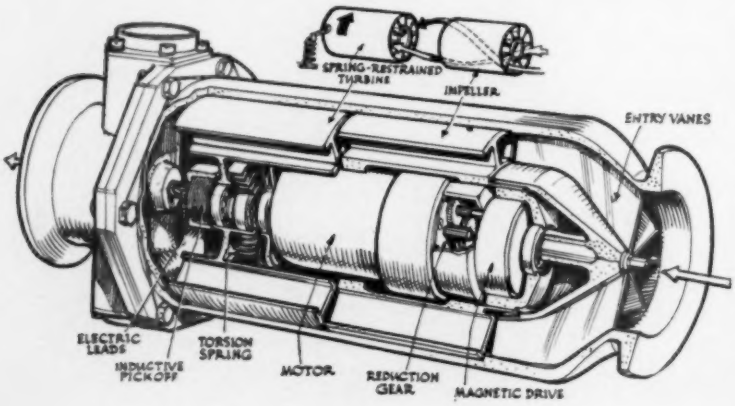
The principal component of this equipment is the metering unit itself. This is an ingenious combination of impeller and torque-measuring turbine by means of which angular momentum is first imparted to the fuel and then removed—the torque needed being proportional to the mass flow.

The impeller is a tubular unit with radial vanes, parallel to the direction of flow, between the inner drum and an outer shroud. This unit is driven by an internal constant-speed DC electric motor which is powered by a rectified 115-V., 400-c.p.s. supply.

An internal gear-train and magnetic coupling complete the drive with the impeller rotating at a steady 100 r.p.m. A magnetic coupling was chosen because it avoids the need for rotary seals and permits the electric motor to be completely segregated from the fluid flow.

Immediately downstream of the impeller is a turbine—an identical cylindrical unit with radial shrouded vanes. This turbine unit is restrained by a spring. The fuel leaves the impeller with an angular velocity, and under its action the turbine will rotate until the spring and fuel torques balance. This angular deflection is proportional to the rate of mass flow.

By means of an induction pick-off the angular deflection is converted into a voltage output which is taken via a rectifier to a rate meter. This AC voltage also feeds into an AC integrating system to an electric motor which drives an integrating counter—set in the rate-meter face—which indicates fuel consumed. The rate meter itself—reading in lb./min. up to a maximum of 300—has an expanded scale over the initial third of the needle movement to give a high accuracy of reading in the cruising range.

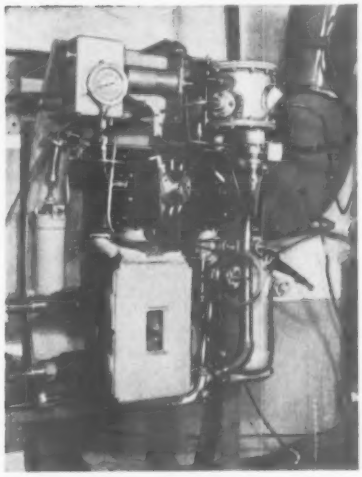


The complete system, which comprises a metering unit measuring about 9 in. long by 4½ in. dia., rate meter measuring just over 7 in. long by 3¼ in. square, and integrating unit a little under 6¾ in. long by 4 in. by 2¾ in., weighs no more than 8 lb. excluding the linking cables. The metering unit is designed to function from −65° C. to 100° C.

Apart from the accuracy of indication the unit offers, it has the additional advantage that it is of the fail-safe type—if the electrical supply is cut off and the impeller stops rotating, there is no added restriction to the fuel flow. Tests have shown that the unit has an extremely low pressure drop and it is not necessary to allow for straight pipe runs immediately upstream and downstream.

Guide to the Static Displays . . . .

Seen on its ground handling trolley is the Mk. 20 air-to-air refuelling pack produced by Flight Refuelling.



The Godfrey vapour cycle cooling package type VCP-1, designed for cooling airborne equipment, mounted on a panel. The package incorporates all the components required for a complete vapour cycle refrigeration system with the exception of the condenser, which for installation reasons is separate.

(*Continued from page 108*)

J. J. Habershon and Sons, Ltd. (253). A comprehensive range of strip and bar in stainless, alloy, carbon and mild steel, with examples of their application in the aircraft industry. The main feature is the dimensional accuracy produced on the company's new planetary hot mill; the backboard of the stand is a large photograph of this new mill and electronic cold mills.

The Hairlok Co., Ltd. (66). Exhibiting Hairlok rubberized hair; Texfoam latex foam and Texfoam block foam.

Hall and Hall, Ltd. (259). Hallprene synthetic rubber mouldings, sheetings and extrusions for high and low temperature applications, including Hallprene 110 (fluoro silicone) items suitable for jet fuels at temperatures up to 200°C; gaskets and joints in Hallite Red Aero jointing to specification DTD.378A, Hallprene patent fluid seals and other sealing devices.

John Hall and Sons (Bristol and London), Ltd. (205). Manufacturers of aircraft finishes including aero-engine paints, dopes, varnishes, lacquers, etc.

Handley Page, Ltd. (L). Theme of the stand is the company's products over the past 50 years, together with details of the Dart Herald and models of the H.P. 113 laminarized executive transport.

Harley Aircraft Landing Lamps (47). Displayed are the model T mobile floodlight and a wide range of landing lamps for fixed-wing aircraft and helicopters.

The Hawker Siddeley Group, Ltd. (S). A 26-ft. front-fuselage section of the Avro 748, together with display panels featuring the transport; model of H.M.S. "Hampshire" with Armstrong Whitworth Seaslug; film on Seaslug; Avro stand-off bomb display; models of Argosy, A.W. 660, Hunter and Hunter Trainer, Vulcan and Javelin; selection of Armstrong Whitworth Equipment aircraft components; Avro strain gauges, cargo-handling systems. A Seaslug SAM will be shown in the missile park.

Heenan and Froude, Ltd. (82). The principal feature is an artist's impression, in oils, of a new jet engine test plant recently ordered by Rolls-Royce, Ltd., on behalf of Aerolineas Argentinas. Initially arranged to take the Avon engine, it will be capable of taking others of up to 30,000 lb. thrust if required.

Hendrey Relays, Ltd. (221). New products on show for the first time include telemetry instruments; aircraft instruments; aircraft electrical relays; welding timing equipment. Also on show are a spark recorder; pressure pick-up; 26-way rotary switches; climatic seal relays.

W. T. Henley's Telegraph Works Co., Ltd. (120). Tersil aircraft cables and Nyvin cables form the main exhibits. On view for the first time is Craltersil compensating temperature measuring cables, consisting of single conductors with Tersil insulation which replace the Ducralsil types. Other cable exhibits include igniter and ignition cables, miniature cables, R.F. cables and equipment wires.

A Hobson type 368 constant-speed alternator drive.

Hepworth and Grandage (Yeadon), Ltd. (79). A comprehensive range of turbine blades is on display.

High Duty Alloys, Ltd. (166). The main part of this display is of forgings in Hiduminium, steel, titanium and Nimonic alloys. The emphasis is on the way precision forgings can reduce machining times. The exhibits illustrate draftless forgings, totally enclosed die and "re-entry" forgings. Castings and extrusions in Hiduminium alloys are also on show.

High Pressure Components, Ltd. (208). Manufacturers of Gyp range of pipe-to-pipe and re-usable hose couplings; various types of charging and relief valves.

H. M. Hobson, Ltd. (158). Various flying-control feel-simulator units; flap-control units; constant-speed alternator drives; powered flying controls; a reheat control system; air/fuel ratio control; Microjet pressure-ratio control. A master control injection carburetter and a fuel-flow proportioner are also on display.

H.M.L. (Engineering), Ltd. (O.D.S. 1). Manufacturers of diesel- and electric-powered universal hydraulic test rigs.

Honeywell Controls, Ltd. (220). Exhibiting for the first time at Farnborough, the company is displaying a new anti-collision lighting system; a take-off monitor system; a low-cost, gas-driven displacement gyroscope; a miniature rate gyroscope; induction soldering unit; the Honeywell data handling system, an automatic wave analyser; aircraft switches.

Hordern-Richmond, Ltd. (137). The main feature is laminated wood helicopter main and tail rotor blades, including blades in current production for Saunders-Roe, Westland and Bristol aircraft. One exhibit is a section of a main blade, illustrating its construction, different methods of repair and root strength characteristics. Other exhibits include Hydulignum and Jabroc laminated compressed-wood press tools; Permaglass aircraft ducting and drill, trim and assembly jigs; Permaflon processed P.T.F.E. components.

The Hughes-Johnson Stampings, Ltd. (56). Producers of various types of forgings in steel and non-ferrous metals.

Hunting Aircraft, Ltd. (H and 228). On the main stand there is the Jet Provost procedure trainer; models of the armed and unarmed versions of the Jet Provost, the President, the Pembroke and the D.H.121. The subsidiary stand has components illustrating applications of Mhoglas non-metallic heating element in aeronautical and guided missile engineering, and an automatic electronic control system.

The Hymatic Engineering Co., Ltd. (267). On display is a selection of pneumatic equipment for aircraft and missile applications and equipment designed to maintain the operational efficiency, comfort and safety of the aircrew. Products cover reducing valves; butterfly valves; anti-g valves; snap jacks and bottles; personal equipment connectors; and solenoid valves.

Houchin, Ltd. (O.D.S. 20 and Z). Electrical and mechanical engineers.

Imperial Chemical Industries, Ltd. (Metals Division) (57). Two new I.C.I. alloys—titanium 230 and 679—are on show for the first time this year, with two additional grades of commercially pure titanium—125 and 150. Titanium 230 has been developed mainly for aircraft applications and titanium 679 is for aero-engine components.

Imperial Chemical Industries, Ltd. (Paints Division) (80). Details of a chemical resistant finishing scheme incorporating I.C.I. pretreatments and paints for aircraft skins. A comprehensive range of metal pretreatment processes and paint systems for aircraft.

Imperial Chemical Industries, Ltd. (Plastics Division) (86). A new material suitable for moulding, Propathene brand of polypropylene, is featured together with the Kralastic range of extrusion and moulding copolymers. Other products include those in Perspex acrylic sheet; Diakon acrylic moulding and extrusion material; Alkathene; Darvic rigid p.v.c. sheet; Flovic; p.v.c. copolymer foil and Fluon.

Integral, Ltd. (157). In addition to hydraulic pumps, power packs, motors, motor-pump units, flow-balance relief valves and flowmeters, items on public display for the first time include a transistorized rate-of-flow meter, an electronic calibrator, an expanded range tachometer and a computer.

Irving Air Chute of Great Britain, Ltd. (274). Barometric power unit for the automatic opening of parachutes; landing brake parachutes for Vulcan and Lightning; supply-dropping parachutes; and various parachutes for ejection and static seats.

Jablo Plastics Industries, Ltd. (181). Lightweight plastics materials for the aircraft industry. Jablex expanded plastics exhibits in this material demonstrate sound and thermal insulation and vibration absorption in aircraft and Jablite exhibits show economies obtained from insulating large-span aircraft, manufacture and assembly shapes, hangars and airport buildings; the acoustical

Guide to the Static Displays . . . .

Left, the Armstrong Whitworth Aircraft Rollermat cargo handling system in the Argosy.

use of lightweight plastics in airports. Also on view are Jablo Denswood; sheet-metal components, and lightweight sandwich-construction panels.

Jessop-Saville, Ltd. (27). One two-ton titanium ingot in H.46 vacuum-melted steel; one 20-in. (approximately one-ton) titanium ingot; eight vacuum-melted steel zirconium ingots; two smaller ingots, one of vacuum-melted steel and one of titanium. Also various products in titanium and vacuum-melted steel.

K.L.G. Sparking Plugs, Ltd. (1). See Smiths Aviation Division.

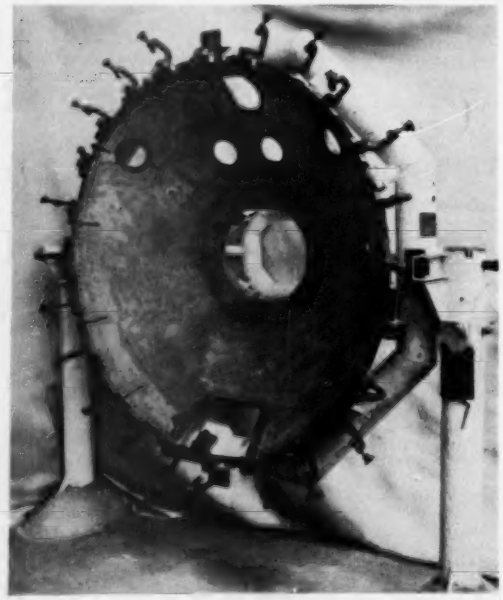
Kelvin and Hughes (Aviation), Ltd. (3 and O.D.S. 13). See Smiths Aviation Division.

The Kenilworth Manufacturing Co., Ltd. (141). Hermetite range of jointing and sealing compounds to M.O.S., A.I.D., C.S. and A.R.B. requirements, including plastic Hermetite 5069 battery-bay paint; Hermetal Double Bond and D.B. Toolform filling and tooling plastics; Plastic metal filler; Kendrol hydraulic and de-icing fluids.

Kent Alloys, Ltd. (93), **Laycock Engineering, Ltd.** (94). Manufacturers of castings, machined parts and assemblies in aluminium, magnesium, magnesium-elektron-zirconium and other alloys. Precision castings for radar and communications equipment.

Above, centre member for an aircraft passenger seat, produced as a draftless forging in Hiduminium R.R.77 for H. C. Shepherd and Co., Ltd., by High Duty Alloys.

Above, shown publicly for the first time at Farnborough is this Integral transistorised rate-of-flow meter.



Left, an aircraft jig assembly and drill fixture made with Kenilworth Manufacturing Double Bond by Handley Page.

The Walter Kidde Co., Ltd. (74). A glass-fibre radome produced by a new technique which ensures an accuracy of .001 in. on wall thickness and .004 in. on diameter; a new passenger emergency oxygen system for civil transports using either lightweight cylinders or liquid-oxygen converters and incorporating four modes of action; a new demand oxygen mask; and a quick donning mask for aircrew.

King Aircraft Corporation (51). New products include cargo-handling and load-securing equipment; Conoseal high-pressure pipe coupling; a range of self-sealing couplings; lightweight pipe connector for variable-diameter ducts; and flexible pipe couplings.

Lancefield Aircraft Components, Ltd. (246). On show are Comet 4 first-class aircraft seats, as supplied to B.E.A. and Aerolineas Argentinas; Comet 4 crew seats; radar waveguides; Lancedown lightweight upholstery filling; exhaust manifolds in stainless steel; general sheet metal work.

Laporte Chemicals, Ltd. (222 and O.D.S. 14 and G). Exhibiting at Farnborough for the first time, this company is featuring H.T.P. as a compact source of power for the aircraft and guided missile industries. One stand is devoted solely to H.T.P. and live firings of a small H.T.P. rocket motor are demonstrated in the outdoor site, together with H.T.P. transportation equipment.

Latex Upholstery, Ltd. (19). The Lonsdale Flyweight range of aircraft passenger chairs manufactured by Aircraft Furnishing, Ltd., is featured on this stand in the form of the triple-seat version. Both fixed and reclining backs are displayed.

Laycock Engineering, Ltd. (94). Light and precision engineers; manufacturers of aircraft sheet metal work, flexible couplings and airfield servicing equipment.

Lep Transport, Ltd. (235). On display is a specimen pack of a flying control unit and various examples of tropical packing and preservation.

Lockheed Precision Products, Ltd. (45). See Automotive Products Co., Ltd.

Lodge Plugs, Ltd. (193). Exhibits include aviation sparking plugs; jet engine igniters and thermocouples; aviation plug servicing equipment; and Sintox precision engineering ceramics.

Joseph Lucas (Batteries), Ltd. (130). In addition to the range of airborne and ground starter aircraft batteries already in production, Lucas is exhibiting two new products for the first time. These are the J0502 24V. 40 amp. hr., and the Lucas No. 3. 24V. 7½ amp. hr. batteries.

Joseph Lucas (Gas Turbine Equipment), Ltd. (114 and O.D.S. B and 18). A comprehensive display of fuel-system and combustion equipment for aircraft gas turbines including sectioned and complete units from fuel systems for such power units as the Rolls-Royce Dart, Avon and Conway and the Bristol Siddeley Orpheus. Equipment on display includes a quick-release coupling for aircraft services; sealing rings; pumps and motors for hydraulic systems.

Lucas-Rotax, Ltd. (115 and O.D.S. 18 and B). See Joseph Lucas, Ltd., and Rotax, Ltd.

Magnesium Elektron, Ltd. (258). Apart from the company's usual display of ultra-light magnesium alloy castings and wrought products, data relating to two new magnesium alloys is displayed, one of them for the first time. Examples of magnesium applications in aero engines and aircraft equipment are also shown.

William Mallinson and Sons, Ltd. (240). Aircraft floors, bulkheads and tables, constructed from the Mallite E.G.B. series of laminates; Mallite galley equipment, constructed using the E.G.B. laminates and including specially developed meal boxes and bar boxes.

Manchester Oil Refinery, Ltd. (89). A demonstration on the uses of M.O.R. inks for the non-destructive flaw detection of aircraft components. Supramor aero hydraulic fluid to D.T.D. 585. Samples of metals and non-metals showing the effectiveness of the M.O.R. flaw-detection fluids are demonstrated.

Marconi's Wireless Telegraph, Co., Ltd. (12 and 14), **Canadian Marconi Co., Ltd.** (15), **Amalgamated Wireless (Australasia), Ltd.** (13), **and Marconi Instruments, Ltd.** (16 and O.D.S. N). Feature covers a wide range of airborne and ground radio navigational aids representing the most modern practice. These include the Marconi AD2300B Doppler navigator (in a special display which enables the visitor to "fly" two legs of a track) and the Canadian Marconi CMA620 Doppler navigator. Many of the other radio navigational aids on view are mounted as live displays. Scale models of three new Marconi high-power radars are also on the combined stands and the new Marconi Instruments mobile demonstration unit containing test equipment is in the outdoor exhibition for the first time.

Marston Excelsior, Ltd. (87). Range of heat exchangers in titanium, stainless steel and light alloy, cabin coolers, oil coolers, fuel heaters and light alloy cooling devices for electronic equipment. Display of laminated plastics components includes fin tips and fairings of asbestos-based laminates, radomes, radar reflectors and a number of glass-fibre components. A sectioned Marlite flexible fuel tank is also on show.

Martin-Baker Aircraft Co., Ltd. (223 and O.D.S. F). A Mk. 4 BS fully automatic ejection seat as fitted to the English Electric Lightning P.1B. A new feature is an electrically operated seat-raising mechanism which replaces the seat-pan raising-handle.

M.B. Metals, Ltd. (214). Design and manufacture of electrical and electronic terminals; aircraft lighting equipment, aircraft armament, guided-missile harnesses, pressure switches, micro switches, butting connectors, special-purpose electronic and electro-mechanical equipment.

McMichael Radio, Ltd. (26). Guided-weapon tracking/guidance cabinet containing rack-mounted assemblies which are part of a shipborne missile guidance installation and include advanced water-cooled units; pre-amplifier modular assemblies comprising transistor and plated circuit equipment for recording data in the upper atmosphere; and various types of aircraft aerials.

Microcell, Ltd. (174 and O.D.S. 12). A range of rocket launchers made of glass fibre reinforced plastic to carry air-to-air and air-to-ground rockets for high-performance aircraft such as the Sea Vixen, Scimitar, Lightning, Hunter and Canberra. These are a retractable 14-tube launcher mounted in the aircraft fuselage; a 24-tube launcher that can be pylon-mounted under the aircraft wing; a 37-tube launcher pylon-mounted under the aircraft wing; a retractable 24-tube launcher.

Ministry of Supply (B and O.D.S. 3). Display of the Blind Landing Experimental Unit's automatic landing systems; a camera for recording visible satellites from R.R.E. Malvern; a vibration-measuring device; the I.A. form tracer optical projection system; a radio interferometer used to determine the track of a transmitting satellite; and guided-weapon flash and instrumentation equipment are on show. In the missile park are the Malkara anti-tank weapon and the Black Knight space research vehicle with a nose section recovered after a launching.

M.L. Aviation, Ltd. (25A and O.D.S. K). In the outdoor display there is a production version of the M.L. Coolair Mk. 5; items of ground handling equipment for the Bloodhound SAM; a mobile air-conditioning unit; and a small universal equipment handling trolley. Indoors there is the M.L. high-pressure pipe coupling system; electrical test equipment; and models and photographs.

Mollart Engineering Co., Ltd. (81). Range of universal joints including the Halo ring joint, a new addition to the company's products.

Mond Nickel Co., Ltd. (171). Refiners of nickel.

Morfax, Ltd. (O.D.S. 4 and V). Products include aircraft handling, maintenance and overhaul equipment; sheet-metal work for gas-turbine engines; precision fabrication and machining. A Morfax mobile workshop will provide services for aircraft in the flying display.

George Spencer Moulton and Co., Ltd. (124). Producers of elastomers to specialized requirements of aircraft industry. Natural and synthetic rubbers for seals, hoses and anti-vibration mountings.

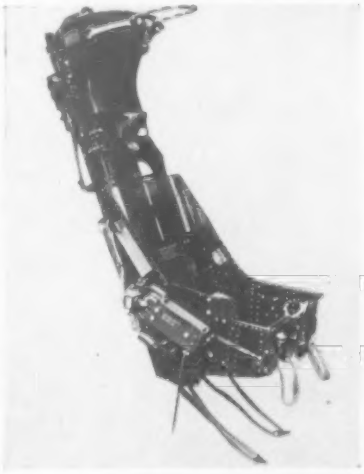
Murex Welding Processes, Ltd. (255). A welding motor-generator and a transformer are shown for the first time as examples of the comprehensive range of Murex welding equipment. Illustrations are shown of other standard equipment ranging from small 200 amp. lightweight portable transformers to large multi-operator sets and engine-driven mobile welding generators. Ground power units and welding accessories are also exhibited.

Murphy Radio, Ltd. (200). Display includes the company's type MR 380 airborne tape reproducer; leader cable ground and airborne equipment for blind landing of aircraft; and the Murphy passenger announcement system.

D. Napier and Son, Ltd. (N and 113). Eland power-pack; Eland N.El.3; Gazelle; Scorpion, Double Scorpion and Triple Scorpion rocket engines; components of the Napier boosting system for helicopters; examples of Napiercast investment casting

Above, the aerial head of the Marconi Type S.244 3 megawatt 10 cm radar heightfinder. Working scale models of this and two other new radars are on view on the Marconi stand.

Below, glass fibre reinforced plastic tool boxes have been made by Microcell for Rolls-Royce.



Above, the Martin-Baker Mk. 4 BS fully automatic ejection seat as fitted to the English Electric Lightning.

Below, a Murex dual-voltage ground power unit of the type supplied to B.O.A.C.

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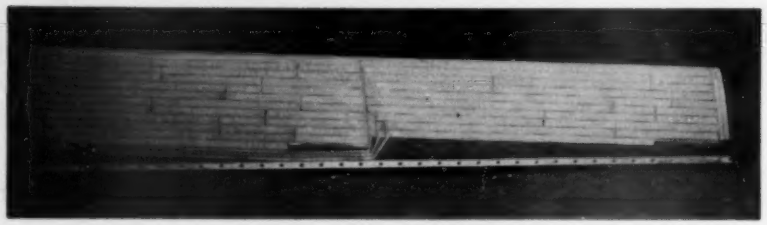
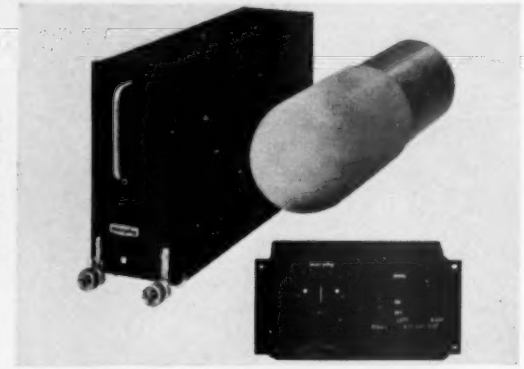
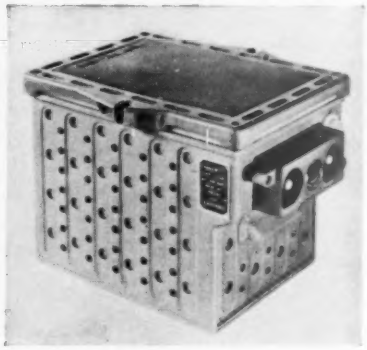


Left, the Napier Spraymat de-icing system as applied to the tailplane of the Vickers Vanguard.

Below, the new Peto and Radford 24V. Dagenite aircraft battery type EDC/F. It is unspillable, ventilated and has a capacity of 17 amp.hr. at 1-hr. rate.



Right, Murphy Radio Leader Cable aircraft equipment which forms part of the B.L.E.U. automatic landing system. The components comprise, left to right, receiver, aerial assembly and control unit.



for aircraft and engines; and models of a number of aircraft and engines are on the main stand. The centre piece of the Napier Spraymat stand is a detachable leading-edge section demonstrating the suitability of Spraymat for the ice protection of high-speed aircraft. Other Spraymat exhibits include tail components, an example of helicopter rotor-blade protection and an auxiliary intake. Also exhibited for the first time are examples of Napier work in the plastics field.

Negretti and Zambra, Ltd. (104). A direct-reading fuel-flow integrator; temperature and pressure units and capsule stacks for control purposes; pressure switches; gauges for boost, altitude and pressure; test-bed thermometers; test barometers and meteorological instruments.

Louis Newmark, Ltd. (189). Pitot static test set; three-axis attitude indicator; transistorized oscilloscope; response tester for functional analysis.

Newton Brothers (Derby), Ltd. (139). Exhibits include a 400 c.p.s. rotary invertor designed to convert DC to single-phase or three-phase DC; DC/DC transistor convertors; two typical servo motors incorporating DC tacho generators and providing outputs of up to 90W and 20W respectively; samples of transistorized voltage regulators for use with electrical equipment on aircraft.

Normalair, Ltd. (75), with **Normalair (Australia) Pty., Ltd.** (76), and **Norma'air (Canada), Ltd.** (77). These stands demonstrate the company's ability to design and supply complete aircraft pressurization, air-conditioning and oxygen systems, with particular emphasis on the most recent form of vapour-cycle cooling and passenger oxygen equipment for civil transports. Special displays are made of a new liquid-oxygen circuit based on the "crew-reserve" principle; electro-pneumatic temperature control; and a revised form of pneumatic flow control.

Northern Aluminium Co., Ltd. (131). The chief exhibit is a wing skin panel, over 23 ft. long and 23 in. wide, machined from plate in Noral B26S WP alloy for the Vickers Vanguard, illustrating Noral's capacity for the production of large stress-relieved plates. Another new development illustrated is the Noral ability to supply square and rectangular extruded sections in BS L 65 and Noral 24ST alloy with guaranteed minimum tensile properties in both transverse directions.

Omes, Ltd. (276). Small axial-type rotors with integral blades together with the company's newest feature, an example of small gas turbine radial flow rotor in nimonic alloy.

Optical Measuring Tools, Ltd. (46). Engineers optical measuring instruments.

Palmer Aero Products, Ltd. (138 and O.D.S. X). Fluodoflex (PTFE), Silvoflex (rubber), Palmaflex (metallic flexible) and Corruflex (corrugated) pipes for engine and airframe hydraulic services; Palmer-Parmatic filters; low-tension harnesses; and other aircraft equipment. In the outdoor display the Palmer self-inflating escape slide as supplied to B.O.A.C. for its Boeing 707s is exhibited.

R. and J. Park, Ltd. (168). The main exhibits are aircraft components which have been packed in an advanced manner; the packs prepared for display purposes enable viewers to see the internal packaging. There are also photographs showing past and present examples of the company's packing and shipping facilities.

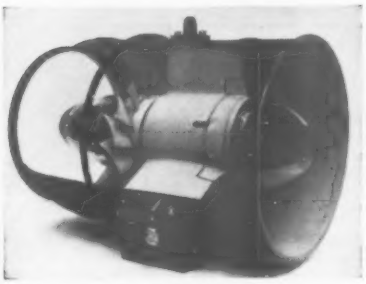
Peto and Radford, Ltd. (257). Interest on this stand is centred on two new Dagenite lightweight batteries recently introduced for civil aircraft. The first, 24 V. type EF is similar in basic design to the Dagenite unspillable battery and the second, type ED, also a 24 volt battery, is of the same size but has a greatly increased capacity. Specimens of other batteries from the complete Dagenite range are also exhibited.

Plannair, Ltd. (65). A range of five air-movement units developed specifically for the Vickers Vanguard varying from a 9 in. model developing 1,300 c.f.m. at a pressure rise of 15 s.w.g. to a 4 in. model with an output of 1 c.f.m. at a pressure rise of 10 s.w.g. at an altitude of 10,000 ft., with two helicopter blowers. The company is also showing for the first time one of its axial-flow blowers with a new silencing feature.

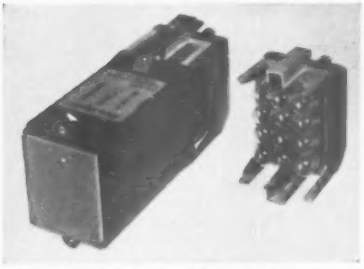
The Plessey Co., Ltd. (62). **Plessey International, Ltd.** (61), and **Wireless Telephone Co., Ltd.** (60). AC techniques in aircraft electrical systems are the theme of the company's aircraft and atomic energy group exhibits and the latest communication and ancillary equipment is displayed by the electronic and equipment group. Products include alternators, transformer-rectifiers, rotary transformers, actuators, ram-air turbines, power packs, UHF transmitter/receivers and VHF equipment.

Precision Rubbers, Ltd. (176). Latest developments in rubber for aircraft applications including two ranges of components based on the fluoro-carbon rubber Viton; Prescolastik silicone compounds; Polyurethane lacquer used for the protection of radomes; and rubbers resistant to Skydrol. Components in natural, synthetic and silicone rubbers to varying specifications.

One of Dunlop's new collapsible rubberized fabric containers for the conveyance of liquids in aircraft.



Designed for supplying emergency electrical power is this Rotax ram air turbo-alternator. It has an output of 15 kVA with a frequency of 400 c.p.s. and a voltage of 208 V.



The Aldis Digilite A100 projection type digital display unit produced by R. B. Pullin. It has 1.2 in. high illuminated figures and 75° angle of view.

R. B. Pullin and Co., Ltd. (71). Range of synchros, servo motors and motor generators. DC motors and DC tachometer generators, gears and gear boxes, transformers, precision filters and chokes, and magnetic amplifiers. A demonstration of AC and DC servo components and instrument motors; turn and slip indicators; g.w. camera.

Purefoy Unit Tooling, Ltd. (107). Specialists in the design and manufacture of standard parts and components for jigs and fixtures.

Pye, Ltd. (109 and O.D.S. Q1 and 9). Mobile VHF radio/telephone equipment; UHF and VHF fixed station equipment; monitor receivers; ground-to-air receivers; transistorized loud hailers; ILS equipment.

The Pyrene Co., Ltd. (83 and O.D.S. P). Producers of fire-detecting and extinguishing systems for aircraft, including smoke- and fire-detector systems; complete fire-safety equipment for aircraft and airfields; airfield crash tenders.

The Rawlplug, Co., Ltd. (210). Several types of all metal "blind" fixing devices and the Rawlnut, which has been approved by R.A.E. Farnborough for class two and three applications in aircraft and can be supplied with a sealed end to protect the thread.

Redifon, Ltd. (8 and 9). Introduction of the company's SSB/ISB range of HF communications transmitters is the main feature of this exhibit. Other equipment on show includes various HF communications receivers and transmitters; teleprinter units; walkie-talkie units; radio-telephone and other components.

Rellumit (London), Ltd. (122 and O.D.S. M). Microfilters fitted with Lenticulaire-type elements for aircraft refuelling; bulk installation filters; Rellumit Fipoca filters; air eliminator and coarse filter combined unit; floating suction loading arm; underwing pressure fuelling hydrant dispenser for flow of 600 g.p.m. Outdoor exhibition includes one-man operated motorized hydrant dispenser for overwing fuelling; mobile hose elevator unit for underwing refuelling; water separator microfilter unit.

Reynolds (Packaging), Ltd. (90). Display of various packs made by the company for the packaging of aircraft, electronic and radio components.

Reynolds T.I. Aluminium, Ltd. (169). Fabricators of structure using aluminium-alloy tubes, extrusions and sheet; manipulated steel and light-alloy tubes and sections; seamless light-alloy pressure vessels; hollow forgings in steel and light alloy.

Reynolds Tube Co., Ltd. (229). Exhibits show the capabilities of Reynolds in the manufacture and manipulation of cold-drawn seamless steel tubing and in the production of precision hollow extrusions in plain carbon and alloy steels and other metals. Exhibits illustrate the possibilities for integral and external integral end forms, the close tolerances obtained and the excellent surface finish.

R.F.D. Co., Ltd. (119). Two new products featured are an inflatable rubber lifejacket for infants and a new R.F.D. inflation system. The new infant lifejacket is intended primarily for youngsters in the age range of 1½ to 4 years; it has a very rapid inflation system.

Rolls-Royce, Ltd. (M). Turbojet engines exhibited are the Conway RCo.10 by-pass engine with thrust reverser and silencing nozzle as for the Boeing 707-420; the Avon RB.146, latest military Avon to be announced; two RB.108 jet-lift engines mounted as in the Short SC.1 installation; the RB.145 lightweight engine developed from the RB.108; an Avon RA.29 from a B.O.A.C. Comet 4. Also exhibited is the Tyne turboprop and a feature covering the RB.141 by-pass engine. A display shows parts of both the Dart and Avon engines.

Rotax, Ltd. (116 and O.D.S. B and 18). Complete electrical systems for aircraft and engines and other established Rotax products. Particular emphasis is placed on new equipment such as a brushless alternator, ram-air turbo-alternator, bleed-air turbo-alternator, transistorized inverter, low-pressure pneumatic starter, and navigation-lamp units.

Rotol, Ltd. (30). See Dowty Group.

Rover Gas Turbines, Ltd. (O.D.S. 15 and C1). Manufacturers of auxiliary power units and other small gas turbines for aircraft and industrial use.

Royston Instruments, Ltd. (39). New maintenance and fault-finding play-back equipment which will materially reduce delays and hold-ups due to mechanical failure in aircraft is displayed by the company. It is used in conjunction with the MIDAS flight and crash recorder which is also on view. Also shown is a miniature flight recorder for research purposes and the company's model T.230/7 general-purpose transportable recorder.

This year Redifon is introducing its latest SSB/ISB range of HF communications transmitters—the G420 series. This equipment is now in full production.

Rubery, Owen and Co., Ltd. (163). Exhibit consists of a range of aircraft fasteners.

Salford Electrical Instruments, Ltd. (25). Manufacturers of precision potentiometers; quartz crystals; radio coils, selenium rectifiers; capacitors; aircraft circuit-breakers.

Plessiflex metallic hose on a Bristol Bloodhound installation.

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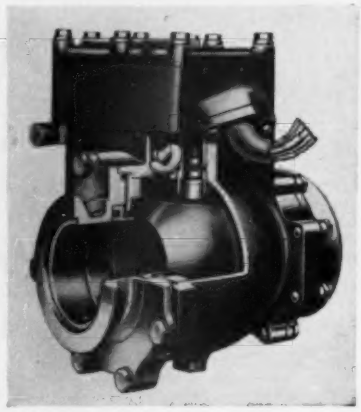
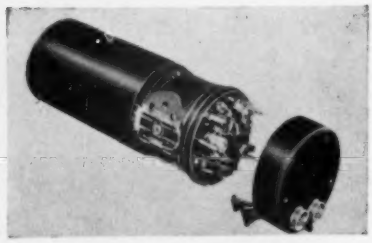
A new R.F.D. product at the show is this inflatable rubber infant lifejacket intended primarily for youngsters in the 1½ to 4-year age group.



The Saunders Valve Co., Mk. 4 motorized spherical plug valve. Illustration shows full bore and annular diaphragm sealing.



This Sperry fully manœuvrable twin gyro stable platform provides a heading reference with a free drift rate of the order of 0.25°/hour and a vertical reference with a drift rate of 2°/hour.

Available in various capacities from 40 tons upwards, this Skyhi power operated tripod jack has a hydraulic lift of 45 in.

W. H. Sanders (Electronics), Ltd. (108). Exhibits cover flexible waveguide assemblies; a laboratory magnetic amplifier; selection of broad band microwave oscillators; microwave ferrite isolators; a universal standing wave meter; and other apparatus covering the microwave telecommunication bands.

Sangamo Weston, Ltd. (152). A new failure warning system for three-phase electrical systems; multi-movement indicators; navigation aids; ground test sets; relays; amplifiers for thermocouple systems.

Joseph Sankey and Sons, Ltd. (63). Products on this stand include turbine casings, centre sections, flame tubes, burner plates and other components for various engine manufacturers; two research combustion chambers for the Rocket Propulsion Establishment, Westcott; typical ammonia cylinders of the range supplied for airborne use to the Services.

Saunders-Roe, Ltd. (F). Models of the P.531 and Skeeter helicopters and a cross-channel ferry version of the Hovercraft of the future.

Saunders Valve Co., Ltd. (265 and O.D.S. 11). On the indoor stand there are Saunders Mk. 4 valves; flap type non-return valves; a new LOX valve with a pneumatic actuator; a spherical disc valve. A feature of the equipment display is the Safran H.T.P. pump, together with sump, trunk and self-contained pumps and industrial versions of H.T.P., LOX and diaphragm valves for ground duty.

The Schermuly Pistol Rocket Apparatus, Ltd. (224). A wide range of aeronautical pyrotechnic stores including guided-missile tracking flares, high-altitude location signals, ground landing flares, high-altitude parachute illuminating flares. New stores of particular interest include helicopter emergency landing flare equipment and combined day and night distress signals.

Sciaky Electric Welding Machines, Ltd. (37). Producers of resistance welding plant of all types; specialists in automatic indexing and multi-head welding machines.

Tom M. Scotney, Ltd. (103). Exhibits include specialized transportation containers for aero engines and guided weapons; information on testing to DEF. 1234 and to test certification for guided weapons; information on Shock-absorption problems.

Scottish Aviation, Ltd. (E). Illustrations and paintings of the Twin Pioneer.

Serck Radiators, Ltd. (285). Fuel-cooled oil-cooler for the D.H. Gnome engine is being shown for the first time; gearbox oil-cooling installation and engine oil-cooler for the Westland Wessex; gearbox oil-cooling installation and engine oil-cooler for the Bristol 192 helicopter; air-cooled oil-coolers for Napier Gazelle and Eland engines; fuel-cooled oil-cooler for Olympus; fuel-cooled rotor-head bearing oil-cooler and air-cooled engine oil-cooler for Fairey Rotodyne.

The Sheffield Smelting Co., Ltd. (101). An up-to-date range of all types of electrical contacts and contact assemblies in precious metals; complete units which pinpoint the contact and contact assemblies therein; special silver solders manufactured solely for aircraft manufacturers to their individual specifications.

Shell-Mex and B.P., Ltd. (143). A model of the 50-ton fuelling vehicles which are being put into service by Shell-Mex and B.P. to speed the turn-round of transatlantic jet airliners is displayed. Known as the Superfueller, it is an articulated vehicle with a capacity of 10,000 Imperial gallons which is capable of delivering fuel to an aircraft at the rate of 700 g.p.m.

Short Brothers and Harland, Ltd. (Q, 26A and O.D.S. E). Models of SC.5 Britannic, aircraft freight-handling system, SC.1 VTOL research aircraft and a VTOL/STOL fighter, together with aircraft passenger seats are on the main stand. Short general-purpose analogue computor and a model of a new multi-purpose computor are on 26A; Short Seacat SAM in outside park.

Siebe Gorman and Co., Ltd. (153). Protective suit to be worn by rocket-handling crews; high-pressure compressed-air breathing apparatus; electrically driven booster pump for charging oxygen or air cylinders; compressed-air power pack for crash rescue work; aircraft seat belts in nylon webbing; Vista full-vision face masks.

Simmonds Aerocessories, Ltd. (188 and O.D.S. U). New products include an aircraft fuel dispensing unit; a new range of light-weight all metal stiffnuts; a miniature barograph; Fram miniature two-stage separator fuel filter.

Skyhi, Ltd. (261). Exhibits include 40-ton tripod jack, hand or power operated; 30-ton lightweight wheel-change jack; 35-ton capacity trolley-type axle jack; range of smaller wheel-change jacks from 8 to 20 tons with varying heights and capacities; inhibitor spray gun; spring-loaded castoring equipment; Polypac products and Dyhalink all-metal power-transmission couplings.

Smart and Brown (Machine Tools), Ltd. (238). Exhibiting for the first time at Farnborough, the company's display covers co-axial connectors; high-temperature stainless-steel, brass and aluminium M4 plugs and sockets; stainless-steel end fittings for flexible hoses; aircraft switches.

Smiths Aviation Division embracing **Smiths Aircraft Instruments, Ltd.** (2), **Kelvin and Hughes (Aviation), Ltd.** (3 and O.D.S. 13), **Waymouth Gauges and Instruments, Ltd.** (4), and **K.L.G. Sparking Plugs, Ltd.** (1). Central feature of the exhibits is a pictorial display of the automatic blind landing system developed by the M.o.S. Blind Landing Experimental Unit. In it a Smiths automatic pilot similar to the SEP.2 and the Smiths Flight System form an essential part of the automatic landing equipment. Also to be seen for the first time is the new Type 4 Smiths Flight System, thermocouples and harnesses featuring compacting techniques, a new miniature relay and the new A.R.B.-approved civil altimeters. The Smiths Flight Data System; a servo altimeter; small motors and synchros; and a wide range of flight, engine, navigational instruments and components are on show. In the outside display, Kelvin Hughes is demonstrating its rapid processing photographic projector.

Smiths Stamping Works (Coventry), Ltd. (28). Products cover compressor wheels and turbine discs, including components in Nimonic and titanium alloys.

Solartron Electronic Group, Ltd. (73). Stand illustrates the many ways in which the Group's equipment fulfils the electronic requirements of the aircraft industry. On display are dynamic analysis equipment; an infinite persistance oscilloscope; Datatape recorder/reproducer system; and pressure sensitive transducers.

Solus-Schall, Ltd. (201). Eresco portable X-ray unit; Magnaflux magnetic crack-detection unit; Zyglo crack detection unit; radioactive isotope containers; ultrasonic flaw detector.

Southern Forge, Ltd. (254). Producers of bars, rods, sections, tubes, forgings and stampings in Alminal aluminium alloys.

Southern Instruments, Ltd. (88). New instruments displayed include 12-channel trace reading equipment; a pre-amplifier panel for use with transducers; and a pre-amplifier for use with Piezo electric transducers. A double-beam oscilloscope; a DC pre-amplifier unit; and a universal recording camera are also exhibited.

Sparklets, Ltd. (190). Manufacturers of dinghies and life-jacket inflation mechanisms; pressure die-castings in aluminium; woven wire braiding for pressurized hose and earthing strip.

S.P.E. Co., Ltd. (260). A full range of fuel booster pumps, including those fitted to a number of transports; representative V-bomber turbine-driven re-fuelling pumps, and pumps for methanol/water injection. H.T.P. fuel and aircraft water systems are also displayed, together with fuel-system recuperators, float level-control valves, non-return valves, cabin-heater system pumps and Flylite flexible hoses, couplings and fittings.

The Sperry Gyroscope Co., Ltd. (279). New developments on this stand include a fully-manœuvrable stable platform for the navigational and attitude reference in high-performance military aircraft; a range of Rotorace gyrosyn compasses; a vertical gyro reference for automatic control and instrumentation systems; windscreen presentation of flight director information; vibration pick-ups for turbine power plants; a radio track coupler system for programmed automatic flying on radio pattern networks; equipment for airborne electronic computer systems; a precision accelerometer for inertial and similar applications and a non-destructive testing instrument.

Standard Telephones and Cables, Ltd. (145 146, 147 and 148). Comprehensive range of airborne and ground communication and navigation equipment, including the new STAN. 7-8-9 high accuracy ILS equipment described in a panoramic display; a new presentation system of the company's range of ADFS; the new DU.5 general purpose VHF ground transmitter and RX.20 receiver. The STR. 23/34/35/36 comprehensive VHF/ILS/VOR equipment; various VHF units; Autoland radio altimeter; transistorized airborne teleprinter/receiver; range of S.T.C. components.

Steel, Peech and Tozer, Ltd. (133). See Samuel Fox and Co., Ltd.

Sterling Metals, Ltd. (10). Major exhibits consist of Bristol Siddeley Double Mamba centre section; Sapphire compressor casing and air-intake casing, Viper air-intake casing; de Havilland Comet hatchway casting, Gyron Junior air-intake casing and Sea Vixon pylon casing; Dowty Vulcan nose undercarriage casting; Dunlop Caravelle landing wheel hub; Napier Gazelle support plate. A comprehensive collection of smaller castings in aluminium and magnesium alloys.

J. Stone and Co. (Charlton), Ltd. (269). Range of sand and gravity die castings in aluminium and magnesium alloys; groups of castings made in the new M.S.R. magnesium alloys; precision castings in aluminium, magnesium, and copper base materials to illustrate the ability of the plaster core, shaw process, and shell moulding methods of manufacture.

J. Stone and Co. (Deptford), Ltd. (270). Various types of light alloy and other non-ferrous rivets, washers and other fasteners; automatic voltage regulators of the sealed type; Stone-Vapor thermostatic temperature controls and relays, as used on the Viscount, Vanguard and Argosy.

Suntex Safety Glass Industries, Ltd. (48). Manufacturers of Perspex cabin windows; canopy mouldings; bullet-proof glass windscreens; rigid P.V.C. moulded panels; and clear acrylic tubing.

Super Oil Seals and Gaskets, Ltd. (118). Five different types of Aeroquip flexible hose; a wide range of SuPerfect oil seals; Redcaps polythene protective caps and plugs.

Talbot Stead Tube, Co., Ltd. (211). On show is stainless heat-resisting seamless, welded and welded drawn steel tube in both straight and manipulated forms, together with a selection of bright steel bars, bright turned shafting and bright drawn wire.

Taylor, Taylor and Hobson, Ltd. (197). Exhibiting for the first time the company is showing a range of measuring instruments. These include the Talyrond Model 50 providing measurement and analysis of roundness; Talysurf models 100, 101 and 3 for surface texture analysis; micro-alignment telescopes; and instrument accessories.

Tecalemit, Ltd. (230 and O.D.S. J). Manufacturer of high-pressure lubricating equipment; jet fuel and oil filters; fuel metering pumps; Titeflex all-metal flexible hose. Foamite, Ltd., is displaying its new Austin Gipsy water foam tender and the Fireball 150-lb. dry chemical powder extinguisher.

Teddington Aircraft Controls, Ltd. (35). On display are components of cabin temperature control systems; engines, spinner, propeller, wing and tail de-icing equipment together with ice-warning units and a visual icing indicator; fuel-tank pressurization components; missile heating and miscellaneous equipment.

Teleflex Products, Ltd. (180). A selection from the company's range of aircraft remote control systems, products including cable tension regulators and flying- and engine-control components. Crew harnesses are also on the stand.

The Telegraph Construction and Maintenance Co., Ltd. (185). The Telcon Metals Division is exhibiting vacuum melted nimocast and other M.o.S. A.I.D. specification alloys for high-temperature service in aircraft; vacuum-melted soft magnetic alloys; super magnetic alloys; special copper and copper alloys. The Telcon Cables Division is showing its standard range of miniature aircraft cables and airfield lighting cables; special composite cables; helical membrane cables.

Thermal Control Co., Ltd. (178). Makers of Firetec aircraft fire-detection equipment and various pressure-operated switches for fuel systems and hydraulic systems.

Thermionic Products (Electronics), Ltd. (281). The Thermionic multi-channel recorder, Mark VI and the B.C.C. multi-channel automatic recording system (MARS). Also shown is a new transistorized recorder shortly to replace the earlier equipments, offering optional fully automatic self-monitoring when recording on up to 20 channels, and a range of VHF communications equipment manufactured by British Communications Corporation, Ltd.

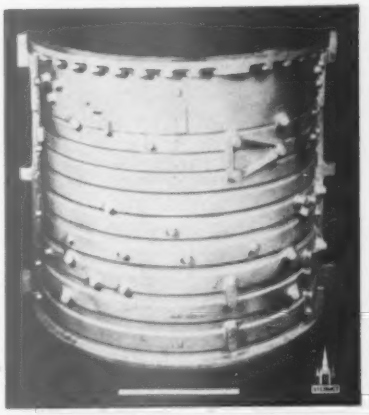
Thermo Plastics, Ltd. (264). Cockpit canopy and windscreen sidepanels for the Hunter; wing-tip for the Twin Pioneer; canopy and radome for N.A.39.

Thorn Electrical Industries, Ltd. (69 and O.D.S. Y). Manufacturers of Plastek panels and other flight-deck illumination systems; range of passenger-facility panels, roof cabin lights and warning signs; electrical connectors and other units.

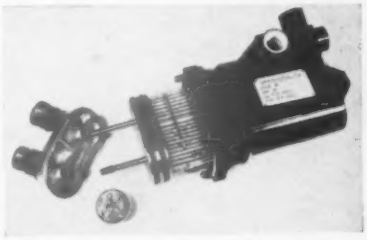
Titanine, Ltd. (159). Manufacturers of aircraft paints and finishes for high-speed flight; temporary protective treatments for aluminium sheets and protective paints for use during contour etching.

Triplex Safety Glass Co., Ltd. (5). Demonstrations of the windscreens for the Lightning, Comet 4 and Vanguard fitted with Triplex gold-film heating; a range of reinforced screens; optically-correct curved-laminated screens for the Valiant.

Ronald Trist and Co., Ltd. (91). This display features a selection of rubber materials designed to meet the requirements of all sections of the aircraft industry. Products include Nitrile rubber compounds; Viton; Butyl rubbers; silicone rubbers; a wide range of standard Seatrist seal types; and rubber-to-metal bonded products.

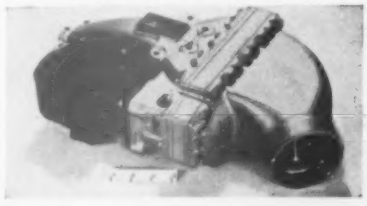


A Bristol Siddeley Sapphire compressor casing produced by Sterling Metals in Aluminium alloy RR.350.



On show for the first time is this Serck fuel-cooled oil-cooler for the D.H. Gnome. It is incorporated in the high-pressure fuel system and is tailored to fit the installation.

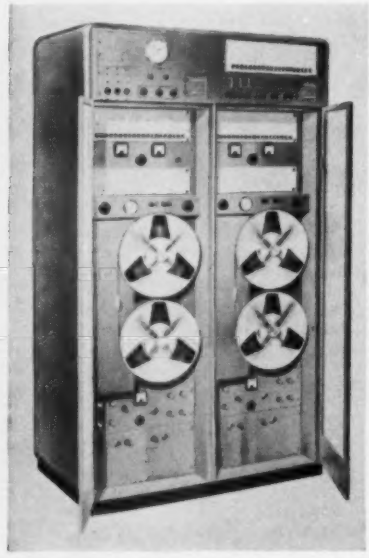
Solus-Schall shows this ultrasonic flow detector. The fluorescent screen displays two or three peaks representing the transmission pulse, the flow echo (if any) and the back wall echo.



A hot air control gate valve manufactured by Teddington Aircraft Controls. These units are produced in light alloy for low temperature applications and nickel-iron castings are used for high temperature work.

Guide to the Static Displays . . . .

Taylor, Taylor and Hobson micro alignment telescope with operator. It is to be demonstrated regularly during the show.



A new multi-channel recorder range has been introduced by Thermionic Products (Electronics), Ltd. The equipment is completely transistorized and records up to 20 channels with or without automatic monitoring.

The Trix Electrical Co., Ltd. (100). Display includes sound amplification equipment of various types for ground and airborne use. This covers the Trixadio TR/520 aircraft passenger control and music system; loudspeakers and microphones.

Tubes, Ltd. (245). Tubular and hollow forgings for aircraft components, including compressor and turbine shafts, transmission and propeller shafts, landing gear-axles, cylinder liners and guided missiles.

Tufnol, Ltd. (242). Aircraft components and production equipment manufactured from Tufnol; examples of Tufnol in its basic forms of sheet, tube and rod.

The Tungum Co., Ltd. (251). Manufacturers of components for guided weapons and radar equipment; springs, spinnings and machined parts.

Turner Brothers Asbestos Co., Ltd. (203). Several aircraft and guided weapons components moulded from Durestos resinated asbestos moulding materials and Duraglas and Duramat glass-fibre reinforced plastics. In addition, the company is exhibiting P.T.F.E. products for the first time.

Turner Manufacturing Co., Ltd. (127). Manufacturers of oleo compression legs; jacks, retracting mechanisms; vacuum and hydraulic pumps; flying controls.

Ultra Electric, Ltd. (262). The company's Special Products Division is exhibiting three new items of equipment. These are an engine-condition analyser type UE.91, a crash position indicator and an electric throttle control system.

Vactric (Control Equipment), Ltd. (173) and **Vactric (Precision Tools), Ltd.** (172). Display of high speed rotary switches; "breadboard" components for constructing servo systems; AC components; DC motors; miniature gearhead.

Valay Industries, Ltd. (183). Aircraft cleaning products including Aerowax high-gloss protection, Aerowash wash-down additive, Aeroval interior cleaner, Wadpol polish.

L. M. Van Moppes and Sons (Diamond Tools), Ltd. (98). The Diatube drill stand is displayed with a new, more powerful air motor suitable for holes and cores up to 8 in. dia. Diamesh roller truers and the Diaform equipment for form grinding is shown with the Diatorc and Diathread equipment for aero gears and threads and the Rotaform punch grinding attachment.

Venner Accumulators, Ltd. (84). Lightweight silver-zinc accumulators for aircraft and guided weapons.

Vernons Industries, Ltd. (O.D.S. I). Manufacturers of aircraft ground servicing trolleys and special electrical equipment.

Vickers-Armstrongs (Aircraft), Ltd. (T). Display panels on the Vanguard and its operation.

Vokes, Ltd. (182). With its subsidiary, Stream-Line Filters, Ltd., this company is showing a representative selection from its range of products covering the filtration requirements of the aircraft industry. These include air, hydraulic and fuel filters.

Ward, Brook and Co., Ltd. (177). Miscellaneous plastic, plastic/metal components including terminal blocks; personal life-saving apparatus; plastic extrusions; foam-rubber mouldings; injection mould tools.

Waymouth Gauges and Instruments, Ltd. (4). See Smiths Aviation Division.

The Wayne Kerr Laboratories, Ltd. (67). A new distance meter for measuring the unbalance of helicopter blades under dynamic conditions without contact is demonstrated in model form.

Wellworthy, Ltd. (150). Sealing rings for jet engines; Spirolox retaining rings; pistons and piston rings; the Al-Fin bimetallic molecular bonding process; and the Wellseal jointing compound.

Western Manufacturing (Reading), Ltd. (266). Selection of mechanical, electrical, hydraulic, pneumatic and thermal products together with Britannia pilot's seat.

Westinghouse Brake and Signal Co., Ltd. (207). Range of semi-conductor switching devices is exhibited. These include Trinistors, controllable silicon rectifiers; high power silicon transistors; and germanium dynistor switches.

Westland Aircraft, Ltd. (J). Scale models of all the Westland helicopters, including a projected pod-type Westminster for military use.

Whitehouse Industries, Ltd. (225). Complete range of Philidas self-locking nuts of turret and industrial types; single- and double-anchor assembly nuts.

Henry Wiggin and Co., Ltd. (17). This stand emphasizes the progress being made in the development of more advanced Nimonic alloys for operation at higher temperatures and on a number of important production improvements of significance to the gas-turbine industry. Comprehensive data is available on the Nimonic alloys up to Nimonic 105, and on the Nimocast alloys up to Nimocast 713C.

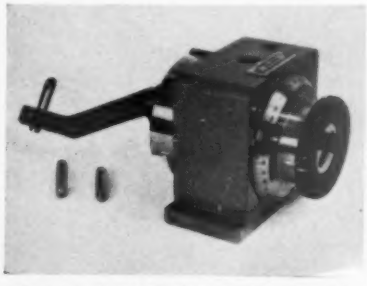
Williamson Manufacturing Co., Ltd. (53). On display is the F.117 hand-held camera recently adopted by the R.A.F., electrically operated version, 28 V., 3.5 amp., format 4½ in. square, capacity 50 ft. by 5 in.

Wilmot Breeden, Ltd. (40). Missile venturi and cone; Rolls-Royce Tyne inlet guide vanes and stator blades; oil-cooled bearing housing for Bristol Olympus; and servo control valve for Napier Eland and Gazelle powerplants.

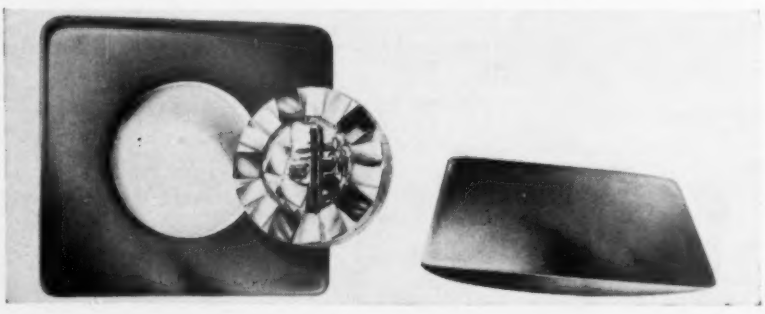
Wireless Telephone Co., Ltd. (60). See The Plessey Co., Ltd.

Xetal Products, Ltd. (43). Manufacturers of rubberized hair to M.o.S. specifications in moulded or sheet form as protective packing for electronic and other equipment; parachute-cushion inserts and seat backs.

Zwicky, Ltd. (275 and O.D.S. H). The new Shell-Mex and B.P. 10,000-gal Severn refueller; the Tagus hydrant dispenser; and the Superjet dispenser; a 4-in. by-pass controller; self-cleaning filters and refuelling nozzles.



The new Diatube drill stand produced by L. M. Van Moppes and Sons for holes and cores up to 8 in. dia.



The Ultra aircraft crash position indicator, showing the transmitter before "potting," and the complete aerofoil. The unit is based on the Sarah search and rescue homing equipment.

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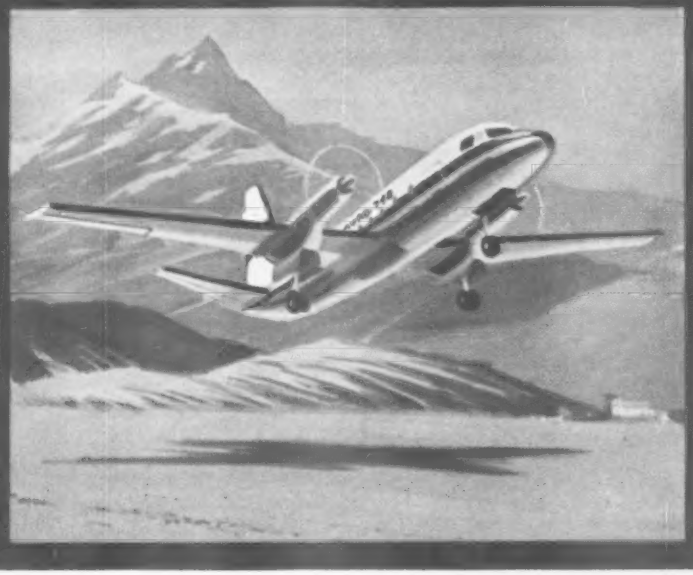
The men who know most about Hawker Siddeley are those closest to world aviation. They know that in the fields of jet passenger and freight transport, military defence, and guided missiles, Hawker Siddeley's record and forward thinking have put its name in the forefront of British and world aviation.

Adopted by R.A.F. Transport Command, the Armstrong Whitworth 660, together with the civil AW Argosy — which has already roused much United States' interest — meets the need for a modern, adaptable transport specially tailored for the growing volume of freight, aircoach and military air traffic in all parts of the world. Hawker Siddeley's other 'bread and butter' civil project, the pressurised, turboprop Avro 748, offers genuine economy to operators on short-to-medium range routes and represents yet another major step by Hawker Siddeley towards bringing the cost of air transportation down to minimum level. The Avro Vulcan V-bomber, described as "the most effective bomber at present in service," will be given extra flexibility in attack by the 'Stand-Off' bomb, also manufactured by A. V. Roe. Seaslug ship-to-air guided weapon, acknowledged as "the best thing the Navy has ever had," is produced by A. W. A., while the formidable Hawker Hunter fulfils a new two-seater role as an operational/advanced trainer. The Two Seater Hunter has already been chosen by the Royal Navy, R.A.F., Holland, Denmark, Peru and India.

HAWKER SIDDELEY



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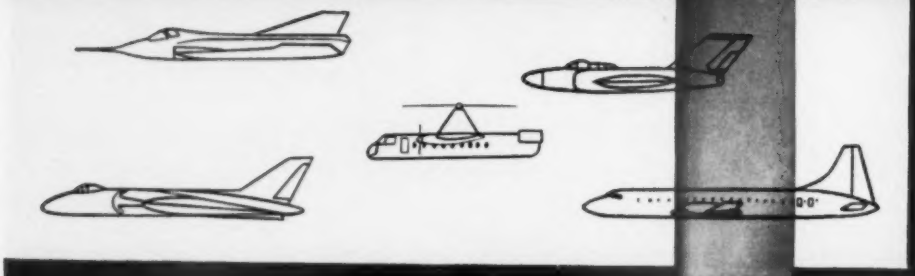
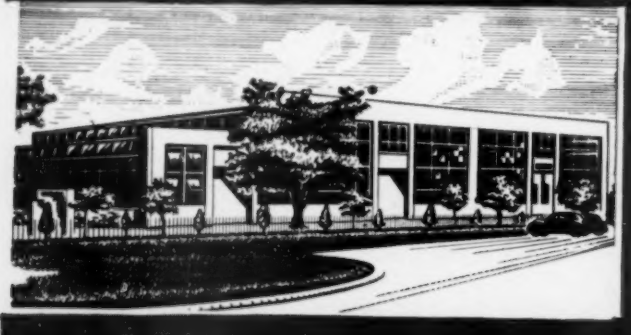
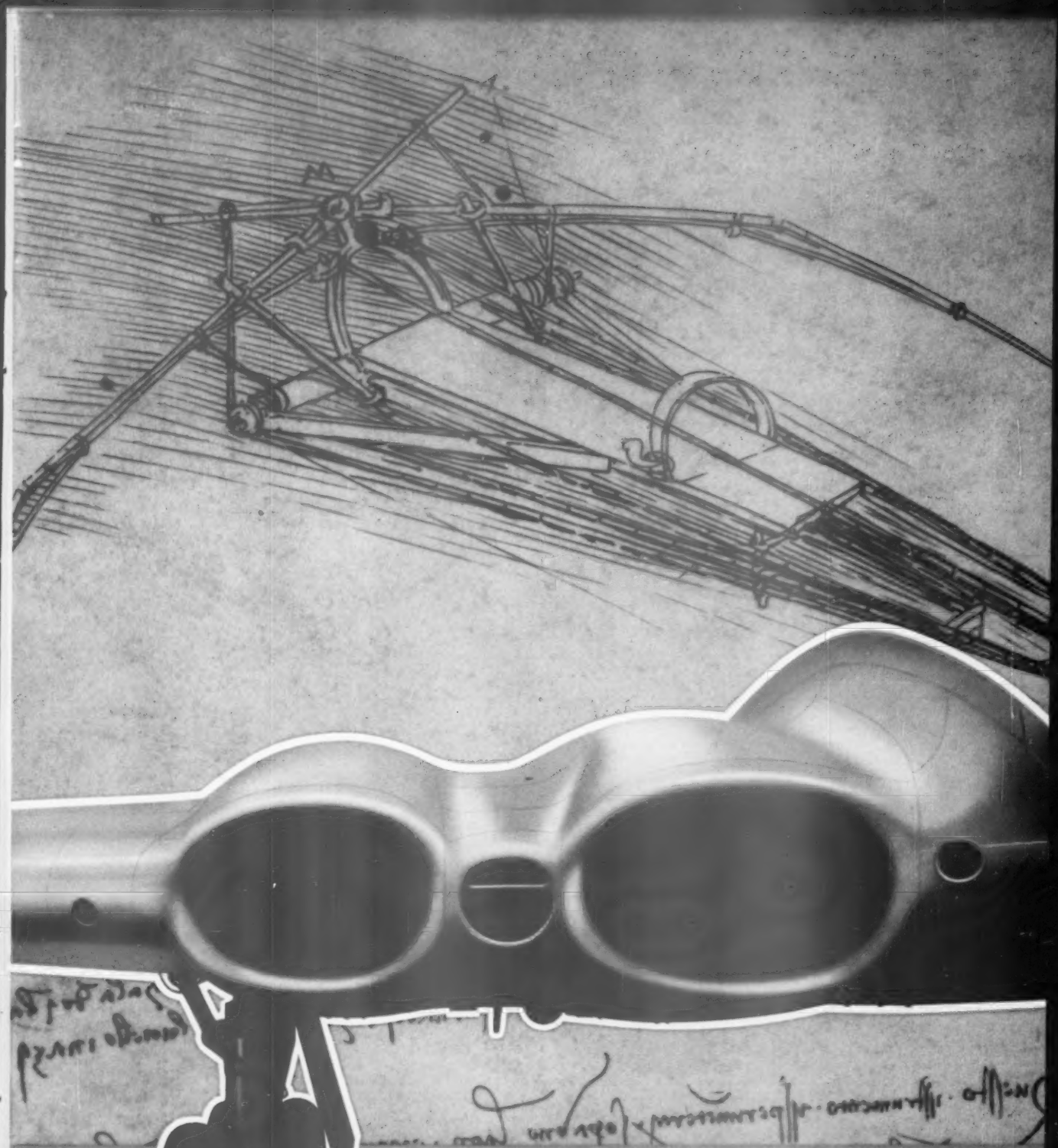




precision blades by **GARRINGTONS**



Background illustration from Leonardo da Vinci's notebooks (c.1506) "Design for a flying machine".

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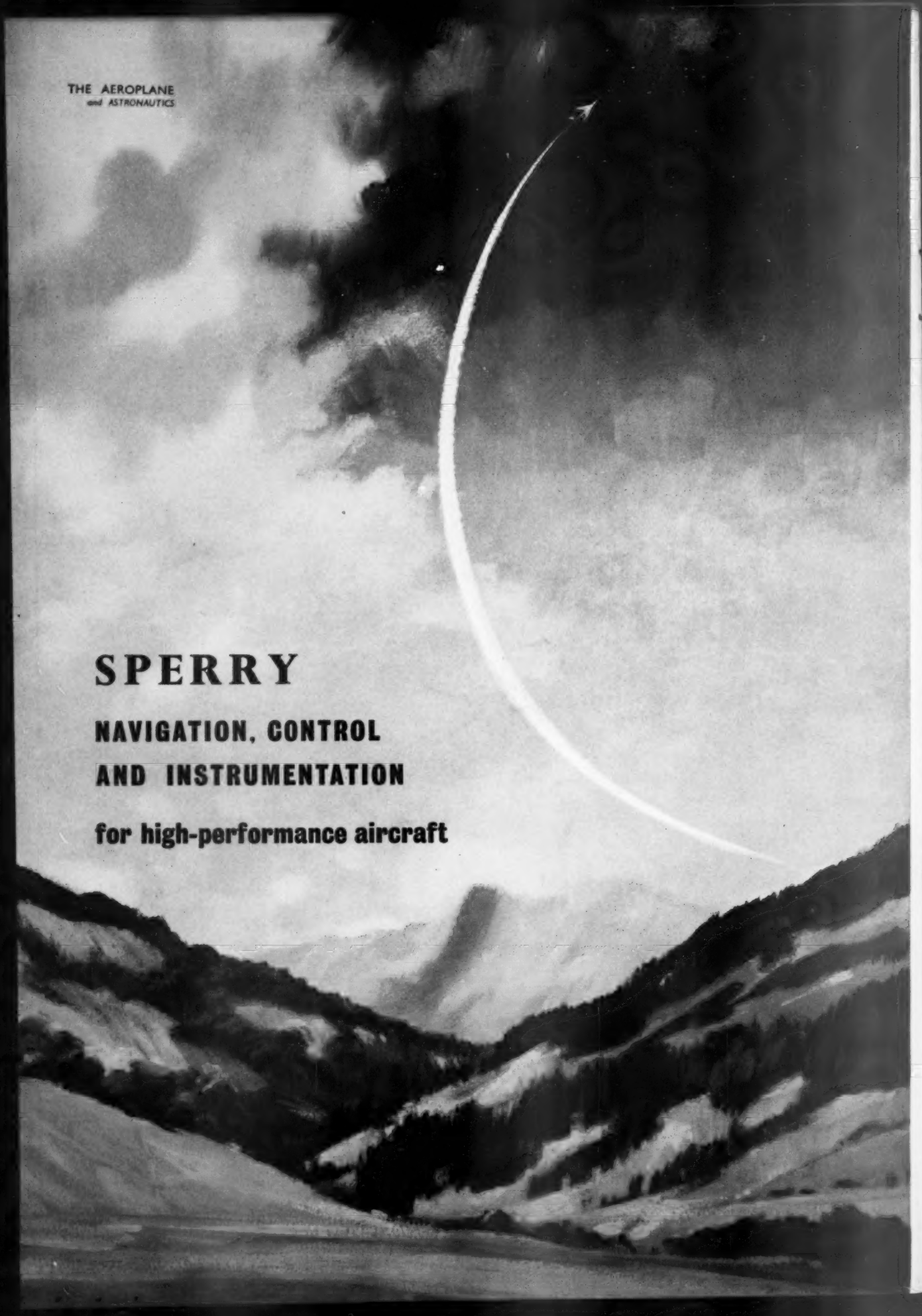

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for high-performance aircraft

Things are humming

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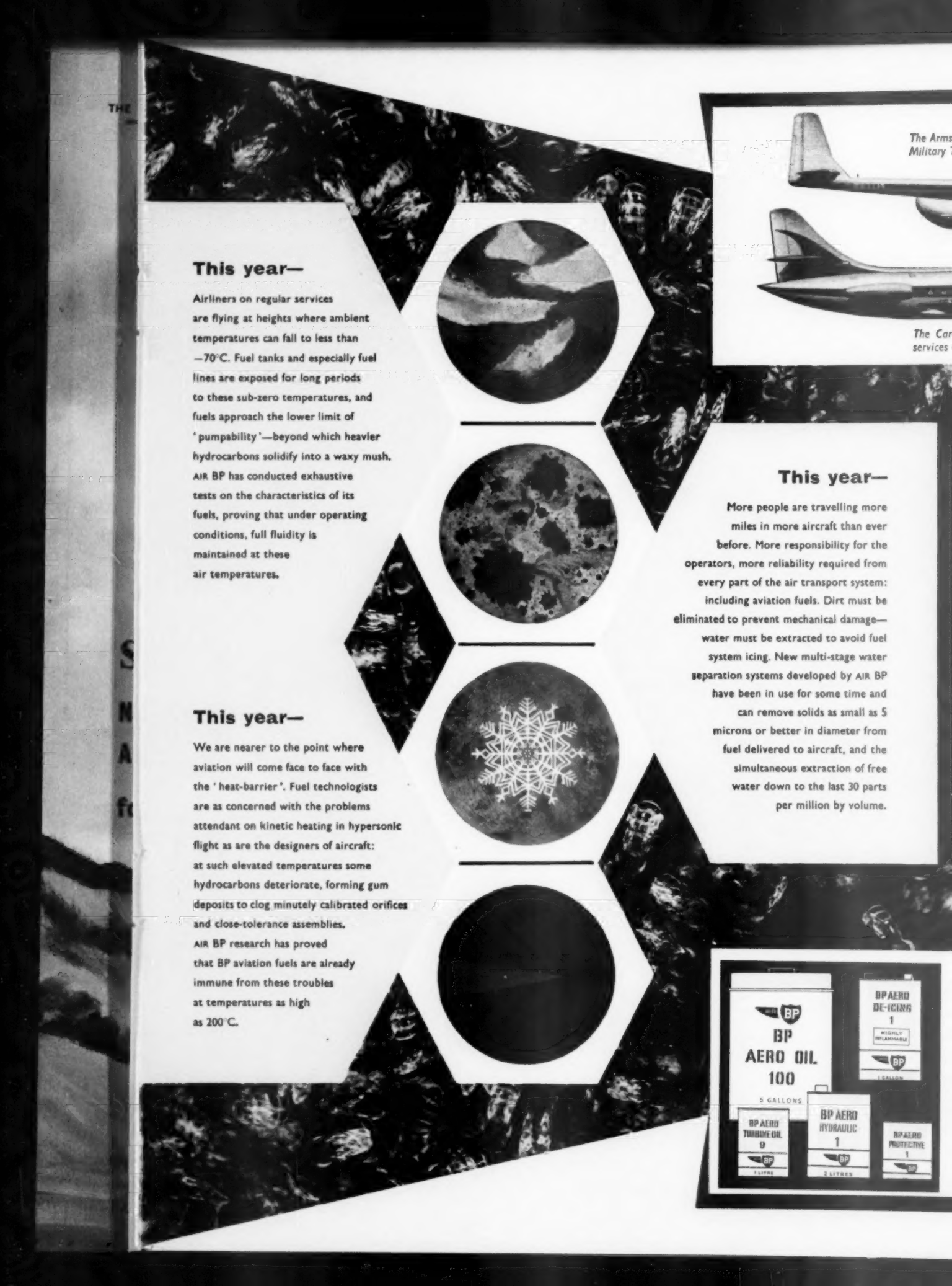
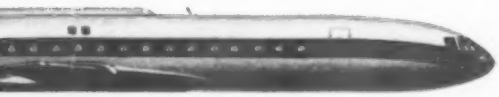
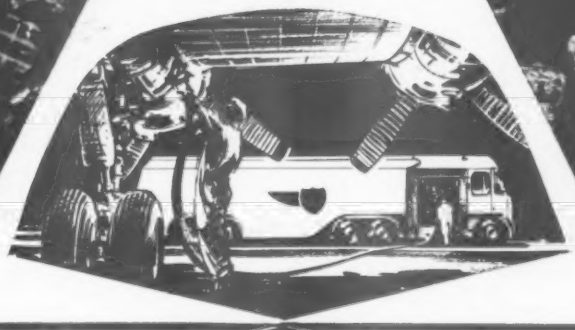
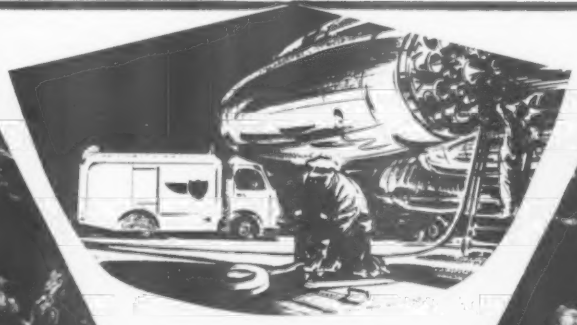

The Arms
Military
The Car
services
This year—
Airliners on regular services are flying at heights where ambient temperatures can fall to less than —70°C. Fuel tanks and especially fuel lines are exposed for long periods to these sub-zero temperatures, and fuels approach the lower limit of 'pumpability'—beyond which heavier hydrocarbons solidify into a waxy mush. AIR BP has conducted exhaustive tests on the characteristics of its fuels, proving that under operating conditions, full fluidity is maintained at these air temperatures.
This year—
More people are travelling more miles in more aircraft than ever before. More responsibility for the operators, more reliability required from every part of the air transport system: including aviation fuels. Dirt must be eliminated to prevent mechanical damage—water must be extracted to avoid fuel system icing. New multi-stage water separation systems developed by AIR BP have been in use for some time and can remove solids as small as 5 microns or better in diameter from fuel delivered to aircraft, and the simultaneous extraction of free water down to the last 30 parts per million by volume.
This year—
We are nearer to the point where aviation will come face to face with the 'heat-barrier'. Fuel technologists are as concerned with the problems attendant on kinetic heating in hypersonic flight as are the designers of aircraft: at such elevated temperatures some hydrocarbons deteriorate, forming gum deposits to clog minutely calibrated orifices and close-tolerance assemblies. AIR BP research has proved that BP aviation fuels are already immune from these troubles at temperatures as high as 200°C.
BP
AERO OIL
100
5 GALLONS
BP AERO
DE-ICING
1
HIGHLY INFLAMMABLE
1 GALLON
BP AERO
TURBINE OIL
9
1 LITRE
BP AERO
HYDRAULIC
1
2 LITRES
BP AERO
PROTECTIVE
1

e Armstrong Whitworth Argosy; Freighter Coach, Air Bus and litary Transport . . . first flew in 1959—on AIR BP fuel.



e Caravelle; joined Air France and SAS in 1959—AIR BP rvices Caravelles on many European routes.





This year—

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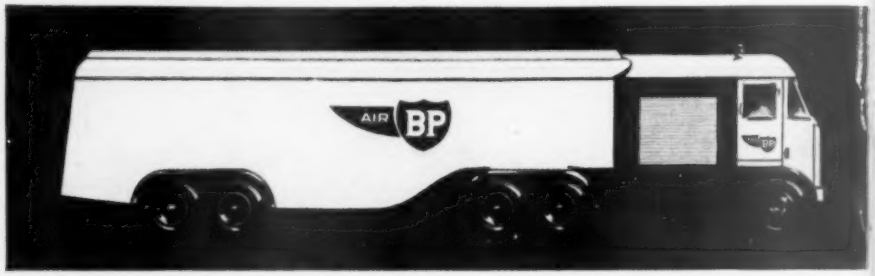

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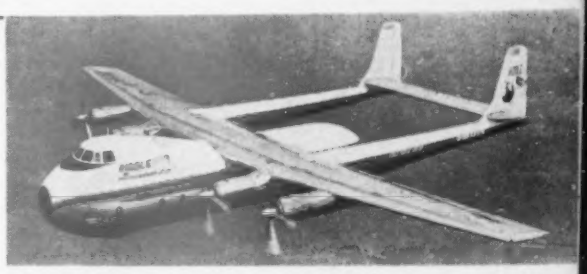
Aircraft, Engines and Missiles

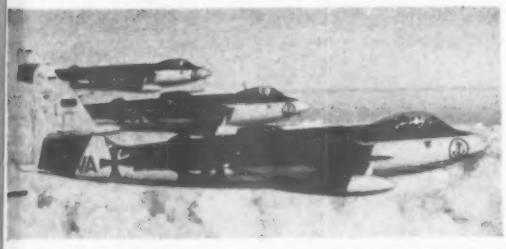
ARMSTRONG WHITWORTH ARGOSY

SINCE the A.W.650 Argosy Dart-engined freighter made its first flight on January 8, the test programme has progressed rapidly and is now some two months ahead of schedule. Five of the initial batch of ten aircraft have flown so far. Firm letters of intent for four Argosies have been received from Riddle Airlines and for three from another unspecified operator.

R.A.F. Transport Command is in the process of ordering 24 A.W.660s, which will each gross about 100,000 lb. and will have vertically opening rear clam-shell doors.

Dimensions.—Span, 115 ft.; length, 86 ft. 9 in.; height, 27 ft.; wing area, 1,458 sq. ft.
Weights.—Basic operating (freighter), 47,000 lb.; max. payload, 27,000 lb.; gross weight, 82,000 lb.
Performance.—Average cruising speed, 276 m.p.h.; balanced field length, 4,050 ft.; ultimate still air range (no reserves), 3,000 st. miles.



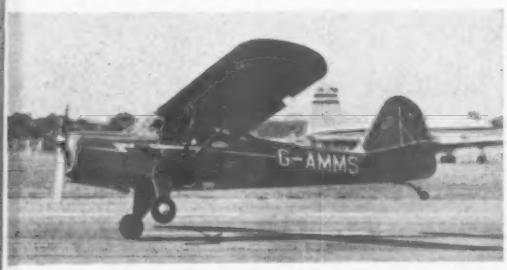


HAWKER SEA HAWK

IN addition to equipping most of the day fighter/strike squadrons of the Royal Navy, Armstrong Whitworth Sea Hawks are operating with the Dutch and West German Navies, and are also to be procured by India. With a 5,400-lb. s.t. Rolls-Royce Nene 103 turbojet, the last production Sea Hawks for the R.N. were redesignated F.B.5s and F.G.A.6s, (data) while the 22 Netherlands aircraft with American radio were known as Mk. 50s.

With taller fins and rudders the 68 German Sea Hawks became the Mks. 100 and 101 (illustration). The latter was produced for reconnaissance duties, carrying Ekco Type 34 radar in an underwing fairing.

Dimensions.—Span, 39 ft.; length, 39 ft. 7 in.; height, 8 ft. 8 in.; wing area, 278 sq. ft.
Weights.—Loaded (clean), 13,200 lb.; gross (with external stores), 16,200 lb.
Performance.—Max. speed, 599 m.p.h. at sea level, M=0.83 (587 m.p.h.) at 20,000 ft.; initial climb, 5,700 ft./min.; radius of action (with drop tanks), 386 miles.



AUSTER J.1s and J.5s

AMONG the versatile Auster range of three/four-seat light aeroplanes in production at Rearsby for flying schools, clubs and private owners, are the J.1N Alpha, the Alpha 5, the J.5L Aiglet Trainer and the J.5P Autocar. These are all variants of the same basic airframe, with 130 or 145 b.h.p. Gipsy Major 1 and 10, or Lycoming 0-240-3 engines. Their cost is just under £4,000 each. Production is also continuing with the military Auster 9, for the Army Air Corps.

The aerobatic Aiglet Trainer is being displayed in the flying programme at Farnborough this year, and the figures below relate to this aircraft.

Dimensions.—Span, 32 ft.; length, 23 ft. 2 in.; height, 6 ft. 6 in.; wing area, 164 sq. ft.
Weights.—Empty, 1,323 lb.; aerobatic (2-seat), 1,950 lb.; gross, 2,200 lb.
Performance.—Max. speed, 129 m.p.h.; cruising speed, 117 m.p.h.; initial climb, 840 ft./min.; stalling speed, 38 m.p.h.; take-off run, 150 yd.; service ceiling 13,700 ft.; range, 440 miles.

AUSTER J/1U WORKMASTER

DEVELOPED especially for the requirements of Crop Culture, Ltd., the Workmaster is a strongly built agricultural aircraft which is claimed to have a greater capacity and performance than any comparable type. It is fitted with a 180 b.h.p. Lycoming 0-360A flat-four engine, and has a 100-gal. spray tank alongside the pilot. A second seat is provided in tandem for occasional passengers.

Fourteen Workmasters were ordered by Crop Culture and are being delivered with underwing Britten-Norman rotary atomizers. Another J/1U is in service in France as a four-seater for rescue flights in the Alps. Austers are also producing the more specialized B.8 Agricola for spraying and dusting.

Dimensions.—Span, 36 ft.; length, 23 ft. 7 in. height, 6 ft. 2 in.; wing area, 185 sq. ft.
Weights.—Max. gross, 2,650 lb.
Performance.—Max. speed, 109 m.p.h.; recommended spraying speed, 60–80 m.p.h.; cruising speed (passenger variant), 113 m.p.h.; initial climb (sprayer), 710 ft./min.; stalling speed, 34 m.p.h.; take-off run, 135 yd.

AVIATION TRADERS PRENTICE

SINCE 1956, Aviation Traders (Engineering), Ltd., of Southend have been converting a large number of ex-R.A.F. Prentice trainers to civilian standards. About 280 of these aircraft have been acquired and, after development for a public transport C. of A., steady progress has been made with their sales.

With a 250 b.h.p. Gipsy Queen 30, the Prentice is being used for both private and commercial flying, and for banner and target towing. The cost is about £2,200. A recent development was the provision of a bench-type front seat for three abreast, increasing the short-range capacity to seven persons (illustration) instead of the normal five. A 340 b.h.p. Gipsy Queen 70 engine is also being experimentally installed.

Dimensions.—Span, 46 ft.; length, 31 ft. 6½ in.; height, 10 ft.; wing area, 305 sq. ft.
Weights.—Empty, 3,230 lb.; max. gross, 4,350 lb.
Performance.—Cruising speed, 126.6 m.p.h.; initial climb, 550 ft./min.; service ceiling, 10,500 ft.; take-off to 50 ft., 600 yd.; range 360 n.m.

AVRO VULCAN

THE Vulcan B.1 is now operational with Nos. 83, 101 and 617 Squadrons of No. 1 Group, R.A.F. Bomber Command, which is awaiting delivery of the more advanced Vulcan B.2. This has 17,000-lb. Olympus 201 turbojets, instead of the 12,000- or 13,000-lb. Olympus 102s or 104s of the later production Vulcan 1s.

The Vulcan 2 also has a modified wing of greater span and thinner section, with an extended leading edge, and has elevons instead of the former separate aileron and elevator surfaces. The Vulcan is being developed to carry Blue Steel, the Avro stand-off bomb. The figures below refer to the Vulcan B2, with those of the B.1 in parentheses.

Dimensions.—Span, 111 ft. (99 ft.); length, 97 ft. 1 in.; height, 27 ft. 6 in. (26 ft. 6 in.).
Weights.—Not available.
Performance.—Not available.

AVRO 748

AVRO hope to have the first of two prototypes of their Type 748 feederliner in the air by next February. Development of this new aeroplane, as a Group private venture, was announced only last January, but the company has already been successful in concluding a provisional agreement with the Indian Air Force for the purchase of a quantity of Avro 748s and subsequent license-production of the type in India.

Under a similar arrangement to that recently announced for the Dart Herald, the Ministry of Supply may also purchase three Avro 748s and a "letter of intent" for three has been given by Skyways, Ltd. The aircraft is powered by two 1,740 e.h.p. Rolls-Royce Dart 514 turboprops.

Dimensions.—Span, 95 ft. 0 in.; length, 67 ft. 0 in.; height, 24 ft. 10½ in.; wing area, 795 sq. ft.

Weights.—Basic operating, 19,444 lb.; capacity payload, 9,666 lb.; gross, 33,000 lb.

Performance.—Cont. cruising speed, 265 m.p.h.; balanced field length, 3,500 ft.; max. range (no reserves), 1,877 st. miles.

BLACKBURN N.A.39

AVAILABLE for examination on the ground for the first time at Farnborough this year, the Blackburn N.A.39 is one of 20 pre-production aircraft for the Royal Navy. Seven N.A.39s have flown in the past 15 months, to the M.o.S. schedule drawn up a few years ago, and orders have been placed for subsequent production aircraft.

Powered by two 7,000-lb. D.H. Gyron Junior D.G.J. 1s, the N.A.39 is the first aeroplane designed for low-level high-speed operations, and combines great strength with structural stiffness and a long fatigue life. Boundary layer control over the total span gives the N.A.39 the highest lift coefficient of any swept-wing aircraft.

Dimensions.—Span, 42 ft. 6 in.; length, 62 ft. 4 in.; height, 16 ft.

Weights.—Not available.

Performance.—Not available.

BRISTOL TYPE 192

DESIGNED to meet Service requirements for troop and freight transport, search and rescue operations, ambulance, paratrooping and supply dropping duties, the Bristol 192 first flew on July 5, 1958, and is now in production for the R.A.F. Eight helicopters are now flying and are accumulating flight experience at about 100 hours per month. The first squadron is due in service in Summer, 1960.

The two Napier Gazelle gas turbines of the Type 192 each develop a maximum of 1,650 s.h.p. and are sufficiently powerful for the helicopter to take-off, hover and climb at maximum weight on only one engine. Up to 25 troops can be carried or 6,000 lb. of freight.

Dimensions.—Rotor diameter, 48 ft. 8 in.; overall length, 89 ft. 9½ in.; height, 17 ft.

Weights.—Basic operational, 10,913 lb.; max. gross, 18,000 lb.

Performance.—Cruising speed, 138 m.p.h.; max. climb, 1,175 ft./min.; service ceiling, 13,250 ft.; hovering ceiling (no ground effect), 8,000 ft.; range, 432 miles.

BRISTOL BRITANNIA Mk.1

BRISTOL Aircraft at Filton and Short Bros. and Harland at Belfast are now engaged in delivering a fleet of 20 Britannia C.Mk.1s (illustration) to R.A.F. Transport Command. The first of these military freighters, with their strengthened floors, larger doors and 113 rearward-facing seats, reached No. 99 Squadron at Lyneham earlier this year. The R.A.F. also has three Britannia C.Mk.2s, which are the original 252s ordered by the M.o.S. for trooping flights.

A total of 53 Britannias of different types has been delivered to civil operators. The Britannia Series 310 (data) has 4,120 e.h.p. Proteus 755s while the R.A.F. variant has 4,445 e.h.p. Proteus 255s.

Dimensions.—Span, 142 ft. 3½ in.; length, 124 ft. 3 in.; height, 37 ft. 6 in.; wing area, 2,075 sq. ft.

Weights.—Basic equipped, 92,040 lb.; max. payload, 28,000 lb.; gross, 180,000 lb.

Performance.—Typical cruising speed, 400 m.p.h.; balanced field length, 7,200 ft.; max. range (no reserves), 5,500 st. miles.

DE HAVILLAND COMET

PRODUCTION of the Comet continues at Hatfield and Chester to fill orders from B.O.A.C. (19), B.E.A. (7), Aerolineas Argentinas (6), E.A.A.C. (2) and Olympic Airways (2). The Comet 4 (data) with its four 10,500 lb.s.t. Rolls-Royce Avon 524 engines, has been in service with B.O.A.C. on the North Atlantic since October 4, 1958, and on routes to the Far East since April 1. Aerolineas Argentinas have been using Comet 4s from Buenos Aires to New York and London since the spring.

The first short-span, long-fuselage Comet 4B of seven ordered by B.E.A. (illustration) flew on June 27, and will be entering service in the early part of next year.

Dimensions.—Span, 114 ft. 9 in.; length, 111 ft. 6 in.; height, 28 ft. 6 in.; wing area, 2,121 sq. ft.

Weights.—Basic operational, 74,100 lb.; max. payload, 20,900 lb.; gross, 162,000 lb.

Performance.—Cont. cruising speed, 516 m.p.h.; balanced field length, 6,700 ft.; max. range (no reserves), 4,755 st. miles.

DE HAVILLAND HERON

BOTH the Heron and the smaller, twin-engined Dove, continue in small-scale production at de Havilland's Chester factory. More than 500 Doves have now been built and sold throughout the World, and production of the Heron totals just over 130. The Heron provides accommodation for up to 17 passengers and alternative interiors are available for a variety of airline, executive or specialized military rôles.

The possibility of producing a successor to the Heron is being studied by de Havilland, and among the current projects is the D.H.123, a Heron/DC-3 replacement feederliner with two 1,200 s.h.p. turboprops.

Dimensions.—Span, 71 ft. 6 in.; length, 48 ft. 6 in.; height, 15 ft. 7 in.; wing area, 499 sq. ft.

Weights.—Basic operational, 8,996 lb.; max. payload, 3,750 lb.; gross, 13,500 lb.

Performance.—Cruising speed, 183 m.p.h.; balanced field length, 3,570 ft.; max. range, 1,770 st. miles.

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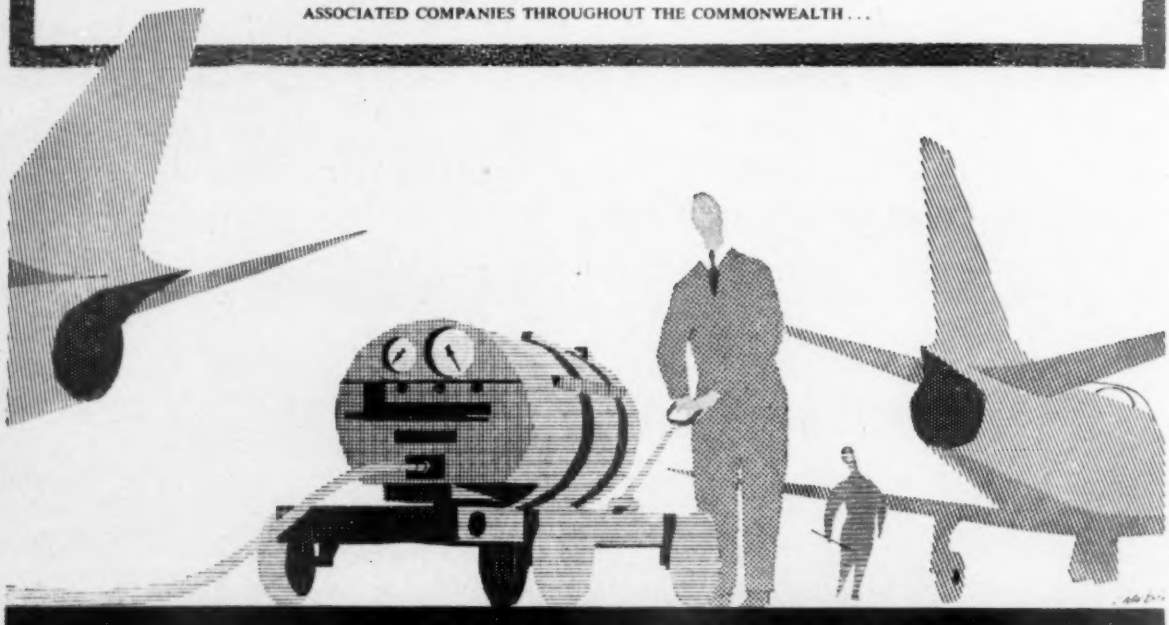

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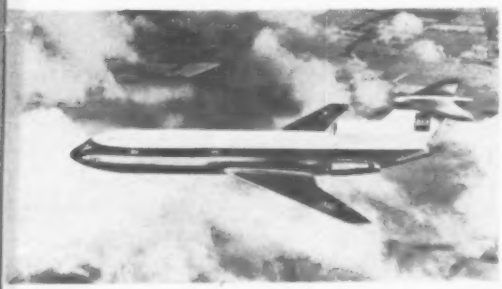
BOC

DE HAVILLAND SEA VIXEN

AFTER nearly eight years of intensive development the Sea Vixen became operational with the Royal Navy in July, 1959, with the formation of the first unit, No. 892 Squadron, at Yeovilton. The Sea Vixen F.A.W.1 is replacing the Sea Venom in F.A.A. all-weather fighter squadrons, and is the first British interceptor to dispense with gun armament. It is designed to carry four D.H. Firestreak air-to-air missiles and either bombs, drop tanks or underwing rocket pods. There are also twin rocket packs retracting beneath the fuselage.

The Sea Vixen is powered by two 10,000-lb. Rolls-Royce Avon 200 series turbojets.

Dimensions.—Span, 50 ft.; length, 53 ft. 6½ in.; height, 11 ft.
Weights.—Not available.
Performance.—Not available.



AIRCO D.H.121

THE first announced "second-generation" turbojet transport, the D.H.121 is being developed initially for B.E.A. by a consortium of manufacturers led by The de Havilland Aircraft Co., Ltd. Valuable technical and financial resources are being contributed to Airco by Fairey Aviation and Hunting Aircraft.

The D.H.121 will provide accommodation for 75 to 97 passengers and is designed for ranges of 200 to 1,200 st. miles flying at a best economical cruising speed of 585 m.p.h. at 32,000 ft. A particular feature of the design is the setting of the max. landing weight at 95% of gross weight to provide for fast stopping services without intermediate refuelling. The use of three 10,100-lb. Rolls-Royce R.B.163 turbojets in a rear-fuselage cluster is unique.

Dimensions.—Span, 89 ft. 10 in.; length, 114 ft. 9 in.; height, 27 ft. 6 in.; wing area, 1,350 sq. ft.

Weights.—Basic operating (83-seat), 63,200 lb.; space-limited payload (97-seat), 21,500 lb.; gross, 105,000 lb.

Performance.—Cruising speeds, M = 0.80 at 35,000 ft. for long range, to M = 0.875 at 25,000 ft. for high speed; balanced field length, 6,000 ft.; max. range (typical reserves), 1,800 st. miles.

ENGLISH ELECTRIC CANBERRA

MANY variants of the versatile Canberra, including the B.2, P.R.3, T.4, B(I) and B.6, P.R.7, B.(I)8, P.R.9, U.10, T.11 B.(I)12, T.13, B.20 and T.21 are flying in all parts of the World, but production for the R.A.F. concerns the Canberra T.4, B.8 and P.R.9. May, 1959, marked the tenth anniversary of the Canberra's first flight, by which time 1,335 had been produced in the U.K., U.S.A. and Australia.

The Canberra P.R.9. (data and illustration) has an extended wing for improved high-altitude performance, and is powered by two 10,050-lb. Rolls-Royce Avon 206 turbojets. A recent modification to the P.R.9 involves the provision of a hinged nose and installation of an ejection seat for the navigator.

Dimensions.—Span, 69 ft. 5 in.; length, 66 ft. 8 in.; height, 15 ft. 7 in.
Weights.—Not available.
Performance.—Not available.

ENGLISH ELECTRIC LIGHTNING F.1

SOON to enter R.A.F. service, the English Electric Lightning is the first British supersonic interceptor, and represents an advanced weapons system concept. With two Rolls-Royce Avon 200 series turbojets each of about 14,500 lb. thrust with afterburning, and mounted one above the other in the fuselage, the Lightning has a substantial power excess for rapid take-off, climb and acceleration, but is able to cruise economically on one engine.

Standard armament is two nose-mounted 30 mm. ADEN cannon, plus two D.H. Firestreak AAMs on fuselage mounts, while there is also provision for a fuselage pack containing 48 2-in. rocket projectiles. A two-seat trainer version of the Lightning, the P.11 (photograph), first flew on May 6, and is in production.

Dimensions.—Span, 34 ft. 10 in.; length, 50 ft.; height, 19 ft. 5 in.
Weights.—Not available.
Performance.—Max. speed well above M=2.

FAIREY GANNET

ALTHOUGH the anti-submarine versions of the Fairey Gannet are giving way to helicopters in the Royal Navy, production is continuing at White Waltham with the extensively modified airborne early warning variant to replace the Douglas Skyraider. The Gannet A.E.W.3 comes into experimental service in the immediate future with the formation of No. 700G Flight at Culdrose, about a year after the first flight of the prototype on August 20, 1958.

The Gannet 3 has a completely revised crew layout, with a centre-fuselage cabin for the two operators of the ventral radar in its "guppy" fairing. Power is provided by a 3,875 s.h.p. Double Mamba A.S.M.D.8 (Mk. 112).

Dimensions.—Span, 54 ft. 6 in.; length, 44 ft.; height, 16 ft. 10 in.; wing area, 490 sq. ft.
Weights.—Not available.
Performance.—Not available.

FAIREY ROTODYNE

THE Ministry of Supply recently announced that negotiations had been opened with the company with a view to ordering about 20 Rotodynes for the R.A.F. As soon as these negotiations have been completed, a B.E.A. order for six is likely to be confirmed and the interest of several other operators can be expected to harden. New York Airways has already ordered five and Okanagan Helicopters, one.

All production Rotodynes will be of an enlarged 65-seat type (data) with two 5,000 s.h.p. Tyne turbines. The first of these is expected to fly in the autumn of 1961 and to be in service by late 1963. Meanwhile flight testing continues with the Eland-engined prototype (illustrated).

Dimensions.—Rotor diameter, 104 ft.; length, 64 ft. 6 in.; height, 23 ft. 2 in.
Weights.—Payload, 18,000 lb.; gross, 50,000 lb.
Performance.—Cruising speed, over 200 m.p.h.; max. range, 650 st. miles.

FOLLAND GNAT

SINCE the prototype Gnat lightweight fighter first flew on July 18, 1955, six have been ordered by the M.o.S.; 40 by the Indian Government, plus a manufacturing agreement; 12 and a manufacturing agreement by Finland; and two by Yugoslavia. In addition, development of the two-seat tandem Gnat Trainer (data) resulted in an M.o.S. order for 14 of this type for the R.A.F.

Like the Gnat F.1 (photograph) the Trainer has a Bristol Orpheus turbojet, but uses the less powerful B.Or.4 (Mk. 100) developing 4,230 lb. thrust. From the projected thin-wing Gnat 2 has been suggested a Gnat Trainer Mk. 2, with a 5% leading and trailing-edge flapped-wing and a reheat Orpheus for level supersonic speeds.

Dimensions.—Span, 24 ft.; length, 30 ft. 9 in.; height, 9 ft. 7½ in.; wing area, 175 sq. ft.

Weights.—Basic, 5,070 lb.; normal loaded, 7,435 lb.; max. loaded (with stores), 8,560 lb.

Performance.—Max. speed, M = 0.97; take-off distance, 1,560 ft.; ceiling, over 45,000 ft.; max. endurance, 3 hr.

GARLAND-BIANCHI LINNET

LICENSED construction of the Piel CP-301 Emeraude two-seat light tourer has been undertaken by this company since January, 1956. The first British-built machine, redesignated the Linnet, flew on September 1, 1958.

With a 90 b.h.p. Continental, the Linnet combines performance with economy, and has the low initial cost of about £2,200. The airframe is of wood, with fabric covering, and has been revised to improve the stalling characteristics. Future developments envisaged by Garland-Bianchi Aircraft, who are also agents for French-built Emeraudes, include the installation of a 100 b.h.p. Continental with a Flottorp variable-pitch airscrew, and a sliding canopy.

Dimensions.—Span, 26 ft. 4 in.; length, 20 ft. 9 in.; wing area, 117 sq. ft.

Weights.—Empty, 802 lb.; disposable load, 460 lb.; max. gross, 1,400 lb.

Performance.—Max. speed, 130 m.p.h.; cruising speed, 115 m.p.h.; take-off run, 200 yd.; ceiling, 11,500 ft.; range, 700 plus miles.

GLOSTER JAVELIN

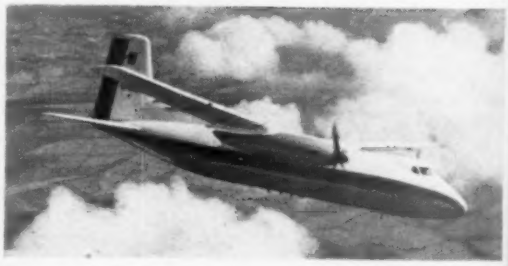
JAVELINS of various marks are now the standard equipment of night- and all-weather fighter squadrons of the R.A.F. The latest production variants are the F.A.W. 7, 8 and 9, although a number of dual-control Javelin T.3s have also been supplied for operational conversion.

The Javelin 7 (photograph) and 8 originally differed only in the type of A.I. radar to be fitted, and both had 11,000-lb.s.t. Sapphire 200 series turbojets. Reheat for these engines became available in time to be incorporated in production Mk. 8s, and Javelins 7s retrospectively fitted with afterburning became Mk. 9s. All carry four Firestreaks, in addition to two 30 mm. ADEN cannon.

Dimensions.—Span, 52 ft.; length, 56 ft. 9 in.; height, 17 ft. 1 in.

Weights.—Not available.

Performance.—Not available.



HANDLEY PAGE DART HERALD

AFTER several years of private-venture development, the Dart Herald has recently been recognized by the Government, which has placed an order for three. These are to be used for five years by B.E.A. on certain Scottish routes. They will, if successful, then be purchased by the Corporation.

The Dart Herald is in production at the Woodley factory of Handley Page (Reading), Ltd., and the first production aircraft, now at the start of flight trials, is expected to obtain a full C. of A. next spring. The Herald's gross weight has recently been increased by 2,000 lb., boosting the payloads by as much as 25%. Take-offs have already been made at 41,000 lb. and further increases can be expected to follow.

Dimensions.—Span, 94 ft. 9½ in.; length, 71 ft. 11 in.; height, 22 ft. 4 in.; wing area, 886 sq. ft.

Weights.—Basic operational, 22,808 lb.; max. payload, 12,000 lb.; gross, 39,000 lb.

Performance.—Cont. cruising speed, 277 m.p.h.; balanced field length, 3,900 ft.; max. range (no reserves), 1,450 st. miles.

HANDLEY PAGE VICTOR

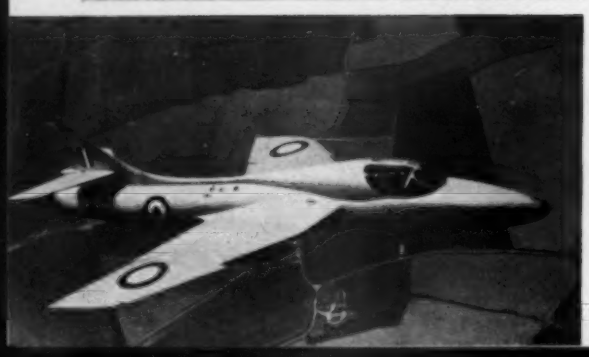
PRODUCTION of the Victor B.1, which equips Nos. 10, 15 and 57 Sqns., Bomber Command, is now continuing alongside the Victor 2. The prototype B.2 first flew on February 20 this year, and has four 17,500-lb. Rolls-Royce Conway turbojets instead of the 11,000-lb. Sapphire 202s of the Victor 1. The Victor 2 (data) also has 10 ft. greater span, enlarged intakes, and retractable scoops forward of the fin.

The scoops supply ram air to turbo-alternators for high-altitude emergency power. That for low altitudes is bled from an Artouste gas turbine in the starboard wing root, and this unit is also used for engine-starting on the ground. The Victor 2 will carry the Avro stand-off bomb and use flight refuelling.

Dimensions.—Span, 120 ft.; length, 114 ft. 11 in.; height, 26 ft. 9 in.

Weights.—Not available.

Performance.—Not available.



HAWKER HUNTER

ONE of the most widely used fighters and advanced trainers in the World, the Hunter has been supplied to the air forces of Belgium, Denmark, Holland, India, Iraq, Jordan, Lebanon, Peru, Sweden and Switzerland, in addition to the R.A.F. and the R.N., and is being built in Holland and Belgium. Latest variants are the F.G.A. 9 and F.R. 10, with 10,050-lb. s.t. Avon 203s, for Middle East operations. The Mk. 9 (data) is intended for ground attack duties, while the Hunter 10 carries a battery of nose cameras in addition to the four 30 mm. ADEN cannon.

The two-seat dual-control Hunter T.7s, T.8s or T.66s have Avon 100 or 200 series engines, and are produced for operational and armament training (photograph).

Dimensions.—Span, 33 ft. 8 in.; length, 45 ft. 10½ in.; height, 13 ft. 2 in.; wing area, 349 sq. ft.

Weights.—Empty, 14,000 lb.; loaded (clean), 18,000 lb.; max. gross, 24,000 lb.

Performance (Mk. 6).—Max. speed, M = 0.93 (710 m.p.h.) at sea level, M = 0.98 (710 m.p.h.) at 36,000 ft.; cruising speed, 560 m.p.h.; initial climb, 15,000 ft./min.; to 45,000 ft., 5 min.; service ceiling, 55,000 ft.

Valiants show their paces

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July	Cape Town	6,060 miles	11 hrs. 28 mins.

Four air forces have adopted Probe and Drogue. This equipment is the product of 25 years' experience of Flight Refuelling Ltd., the pioneers of refuelling in flight.

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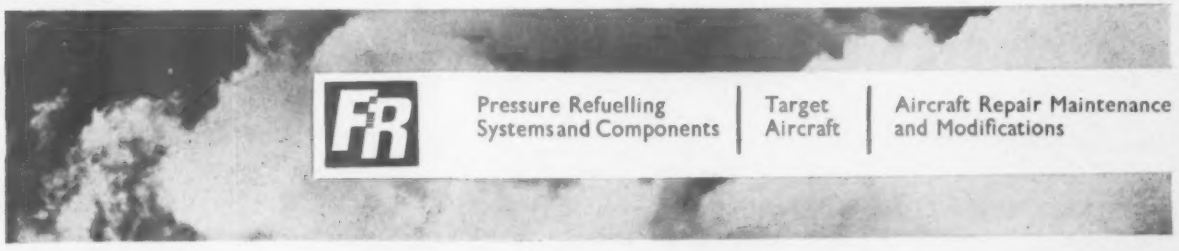

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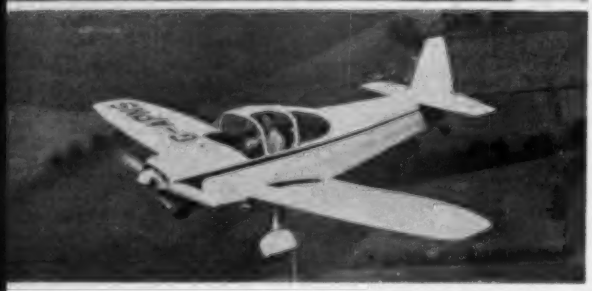


FOLLAND GNAT

SINCE the prototype Gnat lightweight fighter first flew on July 18, 1955, six have been ordered by the M.o.S.; 40 by the Indian Government, plus a manufacturing agreement; 12 and a manufacturing agreement by Finland; and two by Yugoslavia. In addition, development of the two-seat tandem Gnat Trainer (data) resulted in an M.o.S. order for 14 of this type for the R.A.F.

Like the Gnat F.1 (photograph) the Trainer has a Bristol Orpheus turbojet, but uses the less powerful B.Or.4 (Mk. 100) developing 4,230 lb. thrust. From the projected thin-wing Gnat 2 has been suggested a Gnat Trainer Mk. 2, with a 5% leading and trailing-edge flapped-wing and a reheat Orpheus for level supersonic speeds.

Dimensions.—Span, 24 ft.; length, 30 ft. 9 in.; height, 9 ft. 7½ in.; wing area, 175 sq. ft.

Weights.—Basic, 5,070 lb.; normal loaded, 7,435 lb.; max. loaded (with stores), 8,560 lb.

Performance.—Max. speed, M = 0.97; take-off distance, 1,560 ft.; ceiling, over 45,000 ft.; max. endurance, 3 hr.

GARLAND-BIANCHI LINNET

LICENSED construction of the Piel CP-301 Emeraude two-seat light tourer has been undertaken by this company since January, 1956. The first British-built machine, redesignated the Linnet, flew on September 1, 1958.

With a 90 b.h.p. Continental, the Linnet combines performance with economy, and has the low initial cost of about £2,200. The airframe is of wood, with fabric covering, and has been revised to improve the stalling characteristics. Future developments envisaged by Garland-Bianchi Aircraft, who are also agents for French-built Emeraudes, include the installation of a 100 b.h.p. Continental with a Flottorp variable-pitch airscrew, and a sliding canopy.

Dimensions.—Span, 26 ft. 4 in.; length, 20 ft. 9 in.; wing area, 117 sq. ft.

Weights.—Empty, 802 lb.; disposable load, 460 lb.; max. gross, 1,400 lb.

Performance.—Max. speed, 130 m.p.h.; cruising speed, 115 m.p.h.; take-off run, 200 yd.; ceiling, 11,500 ft.; range, 700 plus miles.

GLOSTER JAVELIN

JAVELINS of various marks are now the standard equipment of night- and all-weather fighter squadrons of the R.A.F. The latest production variants are the F.A.W. 7, 8 and 9, although a number of dual-control Javelin T.3s have also been supplied for operational conversion.

The Javelin 7 (photograph) and 8 originally differed only in the type of A.I. radar to be fitted, and both had 11,000-lb.s.t. Sapphire 200 series turbojets. Reheat for these engines became available in time to be incorporated in production Mk. 8s, and Javelins 7s retrospectively fitted with afterburning became Mk. 9s. All carry four Firestreaks, in addition to two 30 mm. ADEN cannon.

Dimensions.—Span, 52 ft.; length, 56 ft. 9 in.; height, 17 ft. 1 in.

Weights.—Not available.

Performance.—Not available.

HANDLEY PAGE DART HERALD

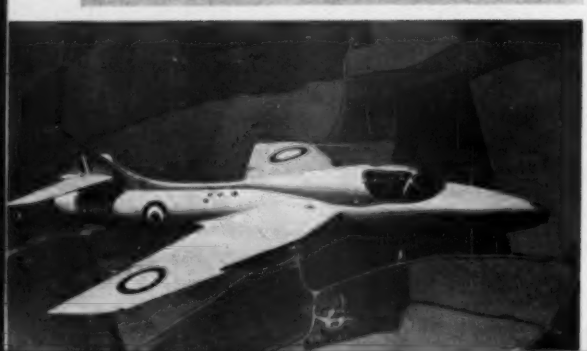
AFTER several years of private-venture development, the Dart Herald has recently been recognized by the Government, which has placed an order for three. These are to be used for five years by B.E.A. on certain Scottish routes. They will, if successful, then be purchased by the Corporation.

The Dart Herald is in production at the Woodley factory of Handley Page (Reading), Ltd., and the first production aircraft, now at the start of flight trials, is expected to obtain a full C. of A. next spring. The Herald's gross weight has recently been increased by 2,000 lb., boosting the payloads by as much as 25%. Take-offs have already been made at 41,000 lb. and further increases can be expected to follow.

Dimensions.—Span, 94 ft. 9½ in.; length, 71 ft. 11 in.; height, 22 ft. 4 in.; wing area, 886 sq. ft.

Weights.—Basic operational, 22,808 lb.; max. payload, 12,000 lb.; gross, 39,000 lb.

Performance.—Cont. cruising speed, 277 m.p.h.; balanced field length, 3,900 ft.; max. range (no reserves), 1,450 st. miles.



HANDLEY PAGE VICTOR

PRODUCTION of the Victor B.1, which equips Nos. 10, 15 and 57 Sqns., Bomber Command, is now continuing alongside the Victor 2. The prototype B.2 first flew on February 20 this year, and has four 17,500-lb. Rolls-Royce Conway turbojets instead of the 11,000-lb. Sapphire 202s of the Victor 1. The Victor 2 (data) also has 10 ft. greater span, enlarged intakes, and retractable scoops forward of the fin.

The scoops supply ram air to turbo-alternators for high-altitude emergency power. That for low altitudes is bled from an Artouste gas turbine in the starboard wing root, and this unit is also used for engine-starting on the ground. The Victor 2 will carry the Avro stand-off bomb and use flight refuelling.

Dimensions.—Span, 120 ft.; length, 114 ft. 11 in.; height, 26 ft. 9 in.

Weights.—Not available.

Performance.—Not available.

HAWKER HUNTER

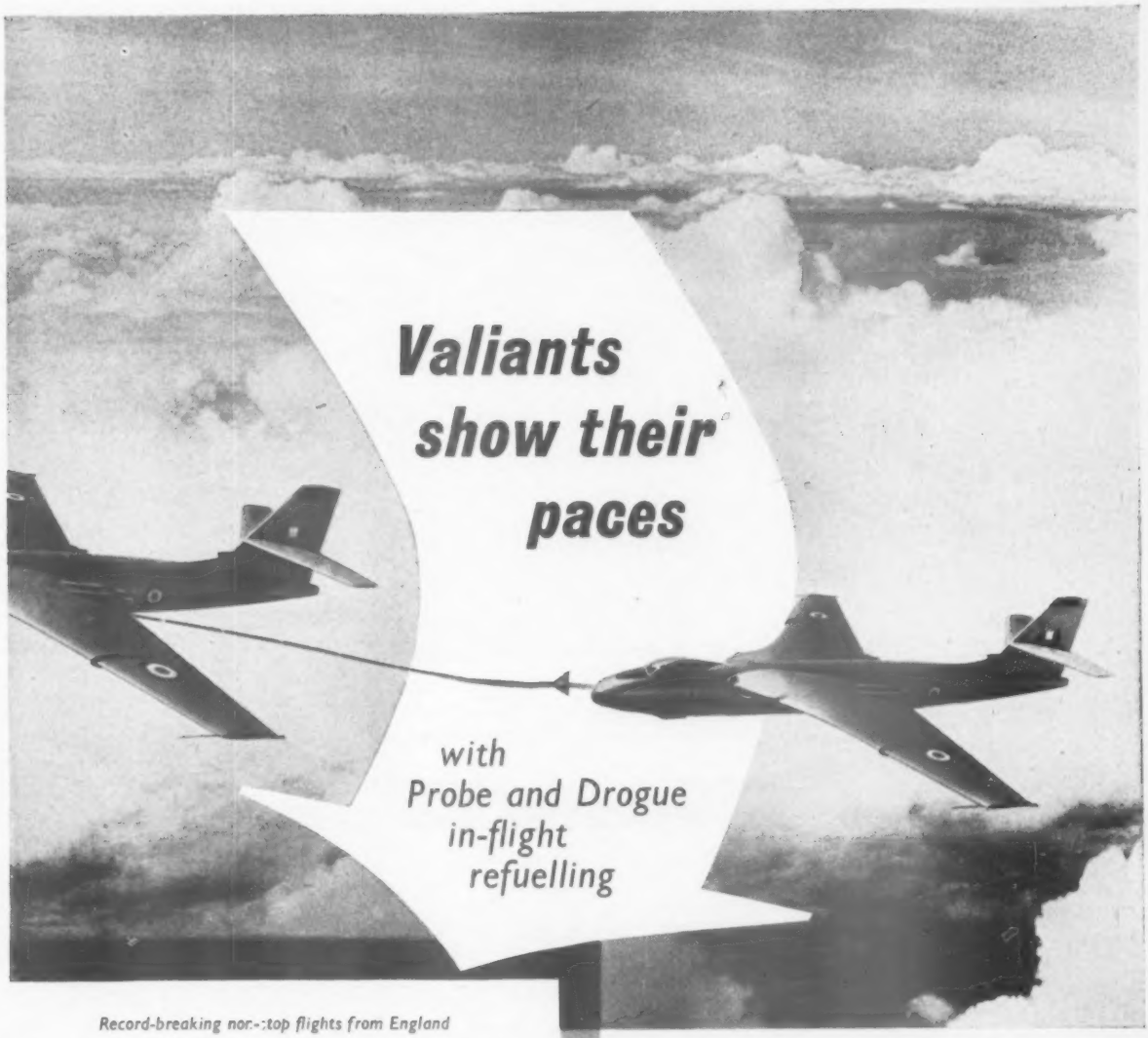
ONE of the most widely used fighters and advanced trainers in the World, the Hunter has been supplied to the air forces of Belgium, Denmark, Holland, India, Iraq, Jordan, Lebanon, Peru, Sweden and Switzerland, in addition to the R.A.F. and the R.N., and is being built in Holland and Belgium. Latest variants are the F.G.A. 9 and F.R. 10, with 10,050-lb. s.t. Avon 203s, for Middle East operations. The Mk. 9 (data) is intended for ground attack duties, while the Hunter 10 carries a battery of nose cameras in addition to the four 30 mm. ADEN cannon.

The two-seat dual-control Hunter T.7s, T.8s or T.66s have Avon 100 or 200 series engines, and are produced for operational and armament training (photograph).

Dimensions.—Span, 33 ft. 8 in.; length, 45 ft. 10½ in.; height, 13 ft. 2 in.; wing area, 349 sq. ft.

Weights.—Empty, 14,000 lb.; loaded (clean), 18,000 lb.; max. gross, 24,000 lb.

Performance (Mk. 6).—Max. speed, M = 0.93 (710 m.p.h.) at sea level, M = 0.98 (710 m.p.h.) at 36,000 ft.; cruising speed, 560 m.p.h.; initial climb, 15,000 ft./min.; to 45,000 ft., 5 min.; service ceiling, 55,000 ft.



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HUNTING JET PROVOST

ALL-JET training in the R.A.F. began recently with the delivery to No. 1 F.T.S., Linton-on-Ouse, of the first Hunting Jet Provost Mk. 3s, following extensive Service experience with pre-production Mk. 1 and 2 aircraft. This has been embodied in the Jet Provost 3, which features such improvements as a clear-vision windscreen and canopy, twin Martin-Baker ejection seats, and wingtip fuel tanks. The armed "overseas" version of the Jet Provost being supplied to Ceylon is designated the T.51.

Development is continuing with an A.S.V.11-powered Jet Provost, instead of the standard 1,750-lb. Viper A.S.V.8. The R.A.A.F. is also evaluating the Jet Provost for *ab initio* training.

Dimensions.—Span, 36 ft. 11 in.; length, 32 ft. 5 in.; height, 10 ft. 2 in.; wing area, 213.7 sq. ft.

Weights.—Loaded (clean), 6,195 lb.; max. gross, 6,830 lb.

Performance.—Max. level speed, 330 m.p.h.; max. design speed, 437 m.p.h.; stalling speed, 75 m.p.h.; initial climb, 2,400 ft./min.; ceiling 35,000 ft.; take-off to 50 ft., 1,990 ft.

HUNTING PEMBROKE

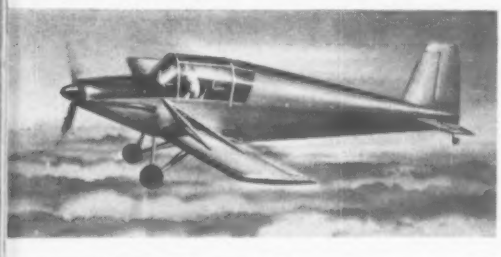
PRODUCTION of the Pembroke and related variants has been continuous since 1953. The twin-Leonides Pembroke was developed from the Prince for the R.A.F. as a staff and general-purpose transport and over 50 have been delivered. More than 60 Pembrokes have also been exported to five European air forces, to Sudan (photo) and Rhodesia.

A civil version of the Pembroke appeared in 1956 as the President, and is available as an airliner, executive transport, or in other special rôles.

Dimensions.—Span, 64 ft. 6 in.; length, 46 ft. 0 in.; height, 16 ft. 0 in.; wing area, 400 sq. ft.

Weights.—Basic operational, 9,136 lb.; max. payload, 3,800 lb.; gross, 13,500 lb.

Performance.—Cont. cruising speed, 165 m.p.h.; balanced field length, 3,800 ft.; max. range (no reserves), 1,160 st. miles.



JACKAROO PARAGON

TWO prototypes of this four-seat, metal-airframed light aeroplane are being built at Thruxton, for private flying, agricultural use or training. Power is provided by a 180 b.h.p. Lycoming O-360-A1A flat-four engine, although should a suitable British engine become available, it will replace the American unit.

The Paragon is designed to be fully aerobatic as a two-seater, or to carry freight in place of the rear bench seat. As an agricultural type, an 80-gal. spray tank may be installed, or dusting hopper, with distribution equipment. Jackaroo Aircraft also specialize in the conversion of Tiger Moths to four-seat machines.

Dimensions.—Span, 40 ft.; length, 26 ft. 6 in.; height, 8 ft.; wing area, 180 sq. ft.

Weights.—Max. gross, 2,500 lb.; max. payload 1,000 lb.

Performance.—Cruising speed, 120 m.p.h.; initial climb, 800 ft./min.; take-off to 50 ft., 850 ft.; range, 480 miles.

LANCASHIRE AIRCRAFT PROSPECTOR

LATE last year, it was announced that Samlesbury Engineering, Ltd., had purchased the former Edgar Percival Aircraft, Ltd., to continue production of the E.P.9 general-purpose aircraft. As the Lancashire Aircraft Corporation, the new concern was to continue producing the E.P.9, renamed the Prospector, at Samlesbury and Squire's Gate.

A number of E.P.9s were already in wide-scale service, particularly on agricultural operations, in which they had proved very successful. One of the latest E.P.9 developments was the installation of a 295 b.h.p. Lycoming GO-480 and a three-bladed Hartzell airscrew (illustrated), instead of the normal 270 b.h.p. Lycoming and two-bladed propeller.

Dimensions.—Span, 43 ft. 6 in.; length, 29 ft. 6 in.; height, 8 ft. 9 in.; wing area, 227.6 sq. ft.

Weights.—Empty, 2,010 lb.; normal loaded, 3,550 lb.; agricultural overload, 4,320 lb.; max. payload, 2,000 lb.

Performance.—Max. speed, 146 m.p.h.; cruising speed, 120 m.p.h.; initial climb, 960 ft./min.; stalling speed, 35 m.p.h.; take-off run to 50 ft., 1,065 ft.; range, 580 miles.

MILES STUDENT

AN interesting approach to the problem of low-cost jet training, the Miles Student has now completed all phases of its flight testing and is available for instructional or liaison duties. Powered by an 880-lb. s.t. Turboméca Marboré IIA turbojet, the Student accommodates two persons side-by-side with dual control in a spacious cabin, which may be adapted if required to seat four.

The Student combines economy with excellent handling qualities, and has a performance not far short of World War II fighter standard, which is quite reasonable for an *ab initio* trainer.

Dimensions.—Span, 29 ft. 2 in.; length, 31 ft. 6 in.; height, 6 ft. 3 in.; gross wing area, 144 sq. ft.

Weights.— Tare (equipped), 2,400 lb.; gross, 3,600 lb.; overload (tip tanks), 3,900 lb.

Performance.—Max. speed, 298 m.p.h.; cruising speed 262 m.p.h.; initial climb, 1,780 ft./min.; stalling speed, 68 m.p.h.; take-off to 50 ft., 740 yd.; range, with tip tanks, 621 miles.

PHOENIX LUTON MINOR and MAJOR

PHOENIX AIRCRAFT, LTD. was formed in 1958 to modernize the pre-War ultra-light designs of Luton Aircraft for amateur constructors. Plans for the new Minor, the L.A.4a, which is designed for engines up to 45 b.h.p., are available for £11 10s., while those for the two-seat folding-wing L.A.5. Major (illustrated), cost £20. A complete L.A.5. costs about £1,600. Phoenix Aircraft also markets kits of parts, and components may be produced for other amateur aircraft.

Phoenix Aircraft are agents for Agusta Aircraft engines and the design and manufacture of aerial spray and dust equipment are also undertaken. Among the new projects at Panshanger is a cabin version of the Luton Minor, the L.A.4c.

L.A.5. Luton Major (62 *b.h.p. Walter Mikron II*) *data* :—

Dimensions.—Span, 35 ft. 2 in. (folded, 11 ft. 8 in.); length, 23 ft. 9 in.; wing area, 163 sq. ft.

Weights.—Empty, 600 lb.; useful load, 430 lb.; loaded, 1,030 lb.

Performance.—Max. speed, 105 m.p.h.; cruising speed, 95 m.p.h.; landing speed, 35 m.p.h.; range, 300 miles; initial climb, 700 ft./min.; take-off run, 80 yd.

ROLLASON TURBULENT

WELL KNOWN for its aircraft and engine maintenance activities, Rollason Aircraft and Engines, Ltd. has been building the French Druine Turbulent under licence at Croydon since 1957. This single-seat ultra-light sports aeroplane is powered by a 30 b.h.p. Ardem 4C02 flat-four engine, which Rollason converts from the standard Volkswagen power unit.

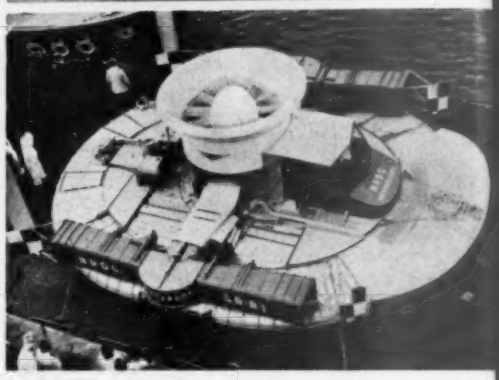
Ten Turbulents have so far been produced, at a sales price of about £950 per aircraft, and one was flown this year under Prince Philip's colours in the National Air Races. Rollasons are also agents for the Thruxton Jackaroo, and the French Jodel D.117, D.R. 100 and Mousquetaire touring aircraft.

Dimensions.—Span, 21 ft. 7 in.; length, 17 ft. 5 in.; height, 5 ft.; wing area, 75.5 sq. ft.

Weights.—Empty weight, 350 lb.; gross weight, 620 lb.

Performance.—Max. speed, 88 m.p.h.; cruising speed, 78 m.p.h.; stalling speed, 28 m.p.h.; initial climb, 700 ft./min.; take-off run, 150 yd.; range, 240 miles.

SAUNDERS-ROE S.R.N.1



MORE popularly known as the Hovercraft, the S.R.N.1 offers an interesting future transport potential which was demonstrated in July this year by the trans-Channel crossing of the prototype. Powered by a single 435 b.h.p. Alvis Leonides engine, the first S.R.N.1 may be regarded as a flying-scale model to prove the principle of Mr. C. S. Cockerell that a cushion of air underneath the craft will produce sufficient lift, at zero incidence and forward speed, to sustain it a few inches in the air.

Provision is made for a crew of two and full instrumentation, although the S.R.N.1 could rise and operate with an overload of, for example, 20 people on its decking. A detailed description of the Hovercraft and a cutaway drawing are on page 112.

Dimensions.—Length, 30 ft.; width, 24 ft.

Weights.—Normal gross, 7,500 lb.

Performance.—Cruising speed, 25 knots; operating "altitude," about 15 in.

SAUNDERS-ROE SKEETER

THE Skeeter is being delivered in A.O.P., flying training and liaison versions, principally to the British Army and the Federal German Army and Navy. The latest production variants for the British Services are the A.O.P.12 and the T.13, which have the 215 h.p. Gipsy Major 215 piston engine. Designation of the German Army version is Mk. 50, while that for the German Navy is the Mk. 51. All these versions are based on the civil Series 7, a two-seat utility helicopter. The Skeeter seats two side-by-side, and an ambulance version can carry two stretchers in external panniers alongside the cabin (photograph).

Dimensions.—Rotor dia., 32 ft.; length of fuselage, 26 ft. 8 in.; height, 7 ft. 6 in.; disc area, 804 sq. ft.

Weights.—Empty, 1,656 lb.; gross, 2,200 lb.; disc loading, 2.86 lb./sq. ft.

Performance.—Cruising speed, 101 m.p.h.; inclined climb, 1,150 ft./min.; service ceiling, 12,800 ft.; range, 213 miles.

SAUNDERS-ROE P.531

DESIGNED as a private venture, the P.531 has a rotor and transmission system based on those of the Skeeter. The prototype was built and flown in seven months. Two prototypes used for initial flight trials, which started on July 20, 1958, are powered by 300 s.h.p. Blackburn Turboméca Turmo 600s, but production aircraft will have the 650 s.h.p. Blackburn A.129, or a derated de Havilland Gnome H.1000, and a new transmission. A P.531 Mk. 2 with A.129 (photograph) made its first flight on August 9.

The Royal Navy has ordered a small evaluation batch of P.531s and larger orders are anticipated from both the Navy and the Army. Normal accommodation is for five, or for a pilot, attendant and two stretchers.

Dimensions.—Rotor dia., 32 ft. 6 in.; fuselage length, 29 ft.; height, 9 ft. 6 in.; disc area 827 sq. ft.

Weights.—Empty, 2,092 lb.; normal take-off, 3,800 lb.; disc loading 4.6 lb./sq. ft.

Performance.—Cruising speed, 115 m.p.h.; inclined climb, 1,600 ft./min.; service ceiling 18,000 ft.; max. range, 322 miles.

SCOTTISH AVIATION TWIN PIONEER

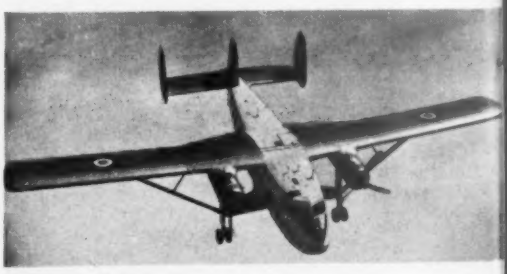
RECENT developments with the Twin Pioneer have produced the Series 3 version, powered by long-stroke 640 h.p. Leonides 531s. These engines bestow several advantages, including a higher gross weight, extra payload or range, higher cruising speed, improved climb and better high-altitude take-off performance, and lower operating costs. Production Series 3s (data below) will be available at the end of this year.

The Twin Pioneer Series 2 has Pratt & Whitney R-1340 engines and is in production for Philippine Air Lines. In addition to about 30 commercial Twin Pioneers in service around the World, another 36 have been delivered to the R.A.F. with the designation Twin Pioneer C.C.1 (illustration).

Dimensions.—Span, 76 ft. 6 in.; length, 45 ft. 3 in.; height, 12 ft. 3 in.; wing area, 670 sq. ft.

Weights.—Basic operational, 10,200 lb.; max. payload, 4,250 lb.; gross, 14,600 lb.

Performance.—Typical cruising speed, 120 m.p.h.; take-off distance to 50 ft., 1,150 ft.; max. range (no reserves), 800 st. miles.



SHORT S.C.1

DESIGNED to explore the possibilities of vertical take-off and landing for fixed-wing aircraft, the Short S.C.1 made its first flight as a conventional aircraft at Boscombe Down on April 2, 1957. This was with the power of its single Rolls-Royce RB.108 propulsion turbojet, but it has a further four swivelling RB.108s mounted vertically in the fuselage for VTOL manoeuvres. The first tethered vertical take-off flight was made on May 26, 1958, and a similar free flight followed in August of that year.

The S.C.1 had not, at the time of going to press, made a full transition in the air from hovering to horizontal flight although trials are in progress.

Dimensions.—Span, 23 ft. 6 in.; length 24 ft. 5 in.; height, 10 ft. 8 in.

Weights.—Loaded, about 8,000 lb.

Performance.—Not available.

SHORT BRITANNIC

BASED on the wing of the Bristol Britannia, the Short Britannic 3A has been chosen as a new strategic aircraft for Transport Command, and an order for 10 is being negotiated by the M.o.S. The 3A will be the largest freighter undertaken in Britain and the cross-section of the fuselage, with a 12-ft. square rear-loading entrance, will be greater than that of any other freight aircraft in the World.

The aircraft is being designed with an eye to the commercial freight market. The first is to fly in 1962; it will enter service in 1964. The engines are Rolls-Royce Tyne R.Ty. 12s.

Dimensions.—Span, 158 ft. 9½ in.; length, 136 ft. 5 in.; height, 47 ft.; wing area, 2,466 sq. ft.

Weights.—Empty weight, 107,155 lb.; capacity payload, 85,000 lb.; gross, 218,000 lb.

Performance.—Max. cruising speed, 385 m.p.h.; take-off field length, 7,000 ft.; max. range, 5,050 st. miles.

SUPERMARINE SCIMITAR

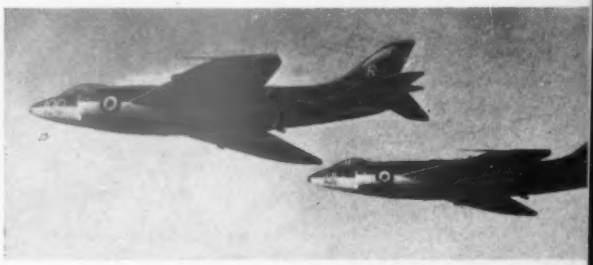
TO date, the Scimitar has replaced the Sea Hawk in two fighter-bomber units of the Royal Navy, Nos. 803 and 807 Sqns. Powered by two 11,250-lb. Avon 202s, the Scimitar is armed with four 30 mm. ADEN cannon, and can carry nuclear or conventional bombs, rockets or other external stores. Mention has been made of the installation of L.A.B.S. (low-altitude bombing system) equipment in the Scimitar, to expedite the delivery of nuclear weapons.

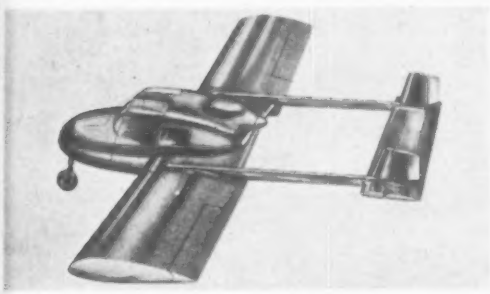
Scimitars of No. 803 Squadron have already been embarked on H.M.S. "Victorious" for a period of sea-going operations, in which their blown flap system proved its value in accelerated take-offs and deck landings.

Dimensions.—Span, 37 ft. 2 in.; length, 55 ft. 4 in.; height, 15 ft.

Weights.—Max. loaded, about 40,000 lb.

Performance.—Not available.





TAWNEY OWL

THIS new ultra-light prototype is nearing completion at Stapleford Tawney, Essex, where it is being built by Thurston Engineering, Ltd. The design of the Owl originated in 1952 at the time of the R.Ae.C. lightplane competition, and it was subsequently revised by Mr. A. M. Creedon to its present form.

It is of all-metal stressed-skin construction, seating two side-by-side, and has a pusher-mounted Porsche 678/4 engine, developing 75 b.h.p. for take-off. A steerable nosewheel undercarriage is fitted, and the roomy cabin is entered like a car. Design load factor is 4.5g, and equipment includes Flottorp variable-pitch propeller, starter and generator.

Dimensions.—Span, 24 ft.; length, 19 ft. 6 in.

Weights.—Empty, 550 lb.; gross, 1,050 lb.

Performance.—Cruising speed, 100 m.p.h.; initial climb, 1,000 ft./min.; stalling speed, 40 m.p.h.; take-off run, 103 yd.; range 350 miles.

VICKERS VALIANT

EIGHT Squadrons in No. 3 Group, Bomber Command, are operational with the Valiant, which was the first V-bomber to enter service, and is no longer in production. Just over 100 Valiants were built powered by Rolls-Royce Avon 100 series turbojets, or, in the case of the later B.K.1 aircraft, which were also equipped for flight refuelling, with the more powerful 200 series engines.

A few Valiants were also produced as the B.(P.R.)1 for high-altitude photographic-reconnaissance duties, and with flight-refuelling equipment, these became B.(P.R.)K.1s. The Valiant was the first R.A.F. aircraft to drop a nuclear weapon, which it did on October 11, 1956.

Dimensions.—Span, 114 ft. 4 in.; length, 108 ft. 3 in.; height, 32 ft. 2 in.; wing area, 2,362 sq. ft.

Weights.—Not available.

Performance.—Cruising speed, M=0.78.

VICKERS VANGUARD

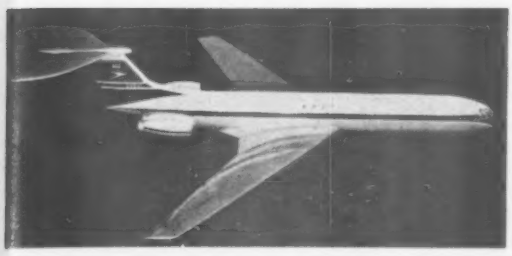
THE Vanguard embarked on its flight development trials on January 20, since when about 400 hr. have been amassed in over 200 flights. Three aircraft are currently involved in the programme; the first is a Vickers-financed prototype while the other two, first flown on April 22 and July 23, respectively, are part of the B.E.A. order for 20. The second B.E.A. aeroplane will be embarking on tropical trials in October, while the third, to fly this year, will be the first fully-furnished and will be used for route proving.

In addition to the B.E.A. order, Vickers have a T.C.A. contract for 20 Vanguards and other airlines are giving it close attention.

Dimensions.—Span, 118 ft. 0 in.; length, 122 ft. 10.4 in.; height, 34 ft. 11 in.; wing area, 1,529 sq. ft.

Weights.—Basic operational, 83,500 lb.; max. payload, 29,000 lb.; gross, 141,000 lb.

Performance.—Cont. cruising speed, 422 m.p.h.; balanced field length, 6,000 ft.; max. range (no reserves), 3,800 st. miles.



VICKERS V.C.10

THE V.C.10 is now the principal concern of the Vickers design team at Weybridge. A full-size mock-up is nearing completion, and the first jigs have been erected. Over 2,000 tunnel-testing hours have been run so far, using 30 models. Target date for the first flight is 1961, with initial deliveries to B.O.A.C. in 1963.

B.O.A.C. signed a contract for 35 V.C.10s in January, 1958, by which time the original project had been "stretched" to be suitable not only for the Commonwealth routes as originally planned, but also for North Atlantic operations. The engines, located four-abreast at the rear of the fuselage, will be Rolls-Royce Conways.

Dimensions.—Span, 140 ft.; length, 158 ft. 10 in.; height, 39 ft. 1½ in.; wing area, 2,800 sq. ft.

Weights.—Payload, 38,000 lb.; gross, 299,000 lb.

VICKERS VISCOUNT 810

SERIES production of the Viscount has now come to an end, with a total of 407 delivered to more than 50 different operators, but Vickers expect to be able to fulfil new orders for the 700 and 810 Series (data right) for several years to come. The total number of hours flown by Viscounts is now close to two million, and American figures show that it is the cheapest modern aircraft to operate in U.S. domestic service.

As service experience accumulates, further improvements in the performance and economics of the Viscount can be expected to become possible.

Dimensions.—Span, 93 ft. 8½ in.; length, 85 ft. 8 in.; height, 26 ft. 9 in.; wing area, 963 sq. ft.

Weights.—Basic operational, 41,276 lb.; max. payload, 15,054 lb.; gross, 72,500 lb.

Performance.—Cont. cruising speed, 351 m.p.h.; balanced field length, 5,950 ft.; max. range (no reserves), 1,890 st. miles.

WESTLAND WESSEX

BASED on the Sikorsky S-58, which has been in production in the U.S.A. for several years, the Wessex has been developed by Westland to offer the advantages of turbine power. In place of the original piston engine, Westland have substituted the 1,450 s.h.p. Napier Gazelle free-turbine engine, and with this engine and provision for carrying the latest search equipment and offensive weapons, the Wessex H.A.S.1 has been put into production for Royal Navy anti-submarine squadrons.

The first production anti-submarine Wessex flew on June 20, 1958, and other versions are available for search, rescue, transport, casualty evacuation and training duties, carrying up to 12 passengers, eight stretchers or 4,000 lb. of freight.

Dimensions.—Rotor dia., 56 ft.; overall length, 65 ft. 9½ in.; height, 15 ft. 10 in.; disc area, 2,460 sq. ft.

Weights.—Empty (operational), 8,350 lb.; normal take-off, 12,600 lb.; disc loading, 5.13 lb./sq. ft.

Performance.—Cruising speed, 127 m.p.h.; inclined climb, 1,650 ft./min.; service ceiling, 17,000 ft.; range, 400–630 miles.

WESTLAND WESTMINSTER

FOLLOWING their successful development of the Dragonfly, Whirlwind and Wessex from the original Sikorsky S-51, S-55 and S-58 designs, Westland embarked on a more ambitious programme based on the big, twin-engined S-56. The Westminster, which has resulted from this programme, bears little resemblance to the S-56, in fact, but uses the entire rotor head and system from the original American design. The fuselage—which can be of stripped "flying crane" type (data and photograph) or more conventional configuration—is entirely new, as is the powerplant installation, comprising two 3,150 s.h.p. Napier Elands.

Possible loads are 45 passengers or 31 stretchers, in the fuselage, or military equipment up to 11,000 lb. carried internally or on external slings.

Dimensions.—Rotor dia., 72 ft.; overall length, 89 ft. 3 in.; height, 22 ft. 3 in.; disc area, 4,070 sq. ft.

Weights.—Empty (operational), 21,600 lb.; gross, 36,000 lb.

Performance.—Cruising speed, 115 m.p.h.; inclined climb, 1,900 ft./min.; max. range, 207 miles.

WESTLAND WHIRLWIND

SEVERAL hundred Whirlwinds have been produced by Westland for civil and military customers in many parts of the World. Initial versions—the H.A.R.1 and 3 for the Royal Navy and H.A.R.2 and 4 for the R.A.F. and Army—were licence-built Sikorsky S-55s, but in the W.S.55 Series 2, or Whirlwind H.A.R.5, the British Alvis Leonides Major 755/1 engine was introduced. The R.A.F. has converted some earlier marks to have this engine, as the H.A.R.6, and the Navy uses the H.A.S.7, also with Leonides Major, for anti-submarine duties.

Latest variants are the two Whirlwind H.CC.8s for the Royal Flight and a prototype with de Havilland Gnome H.1000 turbine (data and photograph), which flew on February 28. As a transport, the Whirlwind carries 10-12 passengers, six stretchers, or equivalent freight.

Dimensions.—Rotor dia., 53 ft.; length of fuselage, 44 ft. 2 in.; height, 15 ft. 7½ in.; disc area, 2,210 sq. ft.

Weights.—Empty (operational), 4,700 lb.; payload, 1,846 lb.; gross, 8,000 lb.

Performance.—Cruising speed, 113 m.p.h.; inclined climb, 1,100 ft./min.; hovering ceiling, 10,500 ft.; range, 275 miles.

WESTLAND WIDGEON

THE Widgeon is based on the well-known S-51 Dragonfly, with a completely new cabin and Whirlwind-type rotor head. It is in production primarily as a general-purpose helicopter for civil users and provides accommodation for pilot and four passengers, or pilot, attendant and two stretchers, or equivalent freight. An external winch can be fitted and the Widgeon operates on wheels or pontoons.

Dragonflies can be converted to Widgeon standard, if required, by substitution of the new front fuselage, rotor head, metal blades and 515 h.p. Alvis Leonides 521/2 engine.

Dimensions.—Rotor dia., 49 ft. 2 in.; fuselage length, 40 ft. 10 in.; height, 13 ft. 2¾ in.; disc area, 1,900 sq. ft.

Weights.—Empty, 4,322 lb.; gross, 5,900 lb.; disc loading, 3.1 lb./sq. ft.

Performance.—Cruising speed, 88 m.p.h.; inclined climb, 1,190 ft./min.; service ceiling, 10,500 ft.; range, 310 miles.

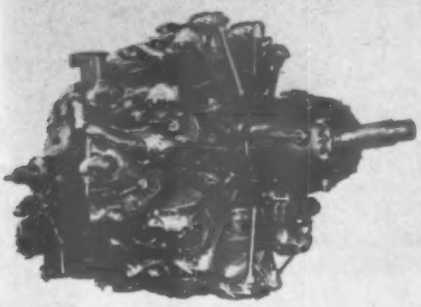
UNDER DEVELOPMENT

Short S.C.7: A light general-purpose freighter being developed as a private venture by Shorts. The payload—which can be freight, passengers, or vehicles—will be about 1½ tons, and it will operate from restricted runways. A prototype will fly in the early autumn of 1960.

Bristol 188: A stainless-steel research aircraft with thin unswept wings, the 188 will probably make its first flight early next year. It is powered by de Havilland Gyron Junior DGJ.10 turbo-jets, each giving 14,000 lb. thrust with reheat. Speeds well above Mach 2.25 should be reached by this aircraft.

TSR.2: This supersonic "Canberra-replacement" aircraft for the R.A.F. is being developed jointly by Vickers-Armstrongs and English Electric. It will be powered by a development of the Bristol Siddeley Olympus. Due for service in 1964-5, the TSR.2 will carry nuclear bombs and air-to-air missiles. Short take-off and landing runs are specified. It will operate on low-level strikes for Army support.

Hawker P.1127: Subject of an M.o.S. design-study contract, the P.1127 is a lightweight VTOL fighter begun as a private venture. It could be used as a NATO third-generation strike fighter. Probable powerplant is a Bristol Siddeley BE.53 "lift-thrust" engine whose jet and fan effluxes can be directed downwards to give VTOL lift and horizontally for thrust in forward flight.



ALVIS LEONIDES MAJOR

THE 14-cylinder Alvis Leonides Major is a twin-row engine developed from the nine-cylinder Leonides which is installed in a wide range of aircraft including the de Havilland Beaver, the Scottish Aviation Pioneer and Twin Pioneer, and the Hunting Provost and Prince variants. The Leonides Major has been designed as an 800-h.p.-class powerplant for fixed-wing aircraft and helicopters; it is installed in the Whirlwind helicopters of the Royal Navy and the R.A.F. Queen's Flight and Austrian Air Force S.55s.

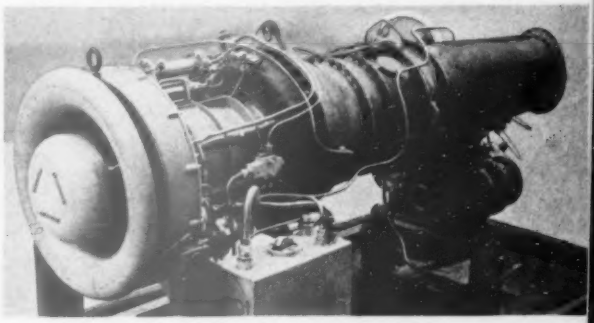
Technical Data.—Air-cooled radial piston engine: twin-row, 14 cylinders; single-stage supercharger. Swept volume, 1,118 cu. in.; length, 54.9 in.; diameter 38.9 in.; dry weight, 1,110 lb.; one-hour power rating, 795 b.h.p.

BLACKBURN A.129

DEVELOPED initially as a helicopter powerplant, the free-turbine A.129 is a turboshaft engine based on the Blackburn Artouste. A new two-stage axial compressor has been added ahead of the Artouste's centrifugal compressor and the power take-off is via a free-turbine and gearbox based on those of the Blackburn Turmo. The first version of the engine delivers 840 s.h.p., but a later version to be type-tested this year will give 970 s.h.p.

Development of this simple and robust engine is expected to be rapid because some 70% of its components are proven from earlier Blackburn engines. An A.129 is flying in the Mk. 2 Saunders-Roe P.531 helicopter and there will also be a Westland Whirlwind installation.

Technical Data.—Shaft turbine: two axial and one centrifugal compressor stages; annular combustion chamber; two-stage compressor turbine; single-stage free power turbine; Pressure ratio, 6.35:1; mass flow, 11.0 lb./sec. Overall length, 5 ft.; weight, 390 lb. Max. power, 840 s.h.p.; s.f.c., 0.77 lb./s.h.p./hr.; one-hour rating, 780 s.h.p., s.f.c. 0.78 lb./s.h.p./hr.



BRISTOL SIDDELEY GAMMA MK. 201

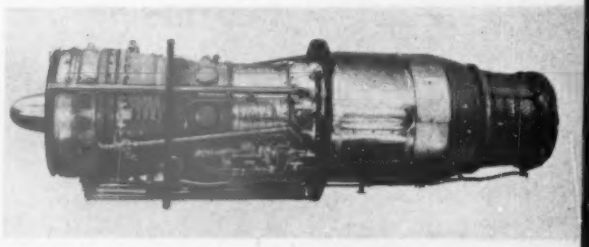
THE Bristol Siddeley Gamma 201 rocket motor powers the Saunders-Roe Black Knight re-entry test vehicle which has reached an altitude of 500 miles during test firings at Woomera. It is a four-barrel motor based on the single-barrel Gamma developed by the Rocket Propulsion Establishment at Westcott. The thrust chambers are gimballed for roll and attitude control. Propellents are kerosene and H.T.P. A cutaway drawing of the motor appears in this issue on page 118.

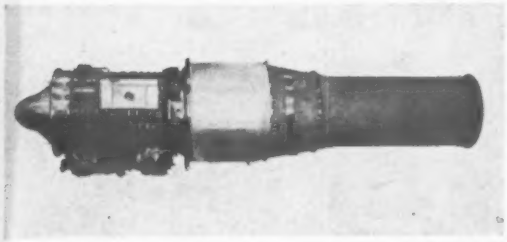
Technical Data.—Liquid-propellent rocket motor: four gimballed thrust chambers; dry weight, 700 lb. Sea-level thrust, 16,400 lb., rising to 19,000 lb. outside the Earth's atmosphere.

BRISTOL SIDDELEY OLYMPUS BOl.7 MK. 201

THE latest Olympus about which details can be given is the Mk. 201, which is in production for the Avro Vulcan B.2. This Olympus has been type-tested at 17,000 lb. thrust. A later version of the engine has been specified for the Vickers/English Electric TSR-2, the new tactical support and reconnaissance aircraft to be produced for the R.A.F. As an indication of the potential of the Olympus, it has been revealed that a development of the Olympus 201 with Bristol Siddeley Solar fully-variable reheat delivers a static thrust greater than 33,000 lb.

Technical Data.—Two-spool turbojet: five-stage low-pressure compressor and seven-stage high-pressure compressor; eight cannular combustion chambers; single-stage high-pressure and single-stage low-pressure turbines. Length, 126.4 in.; diameter, 41.75 in.; weight, 3,600 lb.; take-off thrust, 17,000 lb.





BRISTOL SIDDELEY ORPHEUS B Or.12

THE Bristol Siddeley Orpheus is the powerplant of the Fiat G-91, NATO's lightweight strike fighter; Orpheus engines also power the Folland Gnat, which is in service in India, Finland and Yugoslavia, the Gnat Trainer for the R.A.F., the Dassault Etendard 6, the Breguet Taon, the Lockheed JetStar transport and the Japanese Fuji T1F-2 trainer. Two variants of the engine, the Orpheus B Or.2 and B Or.3 are in production, for the Gnat and G-91 respectively, and others are being developed.

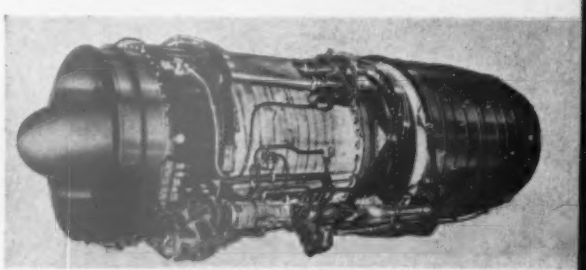
Most important of the new versions is the B Or.12, with a dry thrust of 6,810 lb. which can be increased to 8,170 lb. with simplified reheat. This engine will be flight-tested this year. Agreements for Orpheus production under licence have been made with France, India, Italy and Western Germany.

Technical Data.—(BOr.3).—Turbojet: seven-stage axial compressor; seven cannular combustion chambers; single-stage turbine. Overall length, 96.1 in.; diameter, 32.4 in.; dry weight, 835 lb. Max. thrust, 5,000 lb. at s.f.c. 1.08 lb./lb./hr.; max. continuous thrust, 4,200 lb. at s.f.c. 1.05 lb./lb./hr.

BRISTOL SIDDELEY SAPPHIRE ASSa.7

THE Sapphire 7 powers Handley Page Victor B.1 bombers and Gloster Javelin all-weather fighters. The Mk. 8 and 9 Javelins have the Sapphire 7 with a limited reheat system which increases the maximum thrust from 11,000 lb. to 12,230 lb. The Sapphire was one of the first British axial turbojets to go into production; quantity production was also undertaken in the U.S. where more than 12,000 were built under licence by Curtiss Wright. The Sapphire 9 was a development of the engine rated at 12,700-lb. thrust which did not go into production.

Technical Data.—Turbojet: thirteen-stage axial compressor; annular combustion chamber; two-stage turbine. Overall length, 130.7 in.; diameter, 37.4 in.; dry weight, 3,030 lb. Max. static thrust, 11,000 lb. at s.f.c. 0.885 lb./lb./hr.; max. continuous thrust, 9,600 lb.



BRISTOL SIDDELEY THOR BT.2

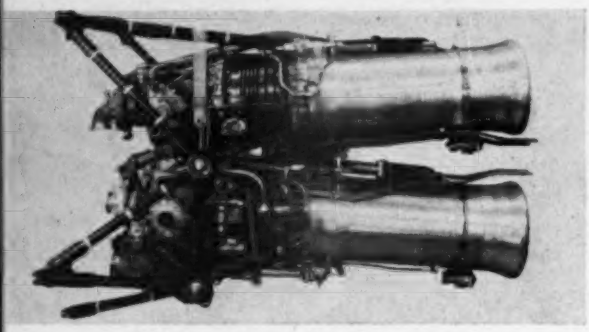
THE Thor ramjet is in production for the Bristol/Ferranti Bloodhound SAM which has two of these engines as its sustainer powerplant. The Bloodhound is in service with the R.A.F. for Britain's air defence and has also been ordered by Sweden. More advanced ramjets are under study by Bristol Siddeley, both for missiles and manned aircraft. The Bristol BRJ 801 is an 18-in. diameter ramjet based on the Thor, which has possibly been developed for the advanced version of the Bloodhound.

Technical Data.—Missile-propulsion ramjet: fixed two-shock centrebody intake; fixed-geometry convergent/divergent nozzle. Length, 103.9 in.; diameter, 15.75 in.; thrust, approx. 16,500 lb. at Mach 3 at sea level.

BRISTOL SIDDELEY VIPER ASV.11

THE Viper was originally designed as a short-life engine to power the Jindivik target drone, but was soon developed as a powerplant for manned aircraft. Two marks are now in quantity production, the 1,750-lb.-thrust ASV.8 for the Hunting Jet Provost 3 and the 2,500-lb.-thrust ASV.11 for the Jindivik 3 and the Macchi MB 326 trainer. From the installation viewpoint the Viper 8 and Viper 11 are interchangeable; the main difference between them is the reduced rotor-hub diameter of the ASV.11 to give a greater mass flow. The Viper is built under licence by Dassault in France and this company has also produced a scaled-up version of the engine known as the Farandole.

Technical Data.—Turbojet: seven-stage axial compressor; annular combustion chamber; single-stage turbine; pressure ratio, 3.9:1; mass flow, 42 lb./sec. Overall length, 63 in.; diameter, 24.55 in.; dry weight, 500 lb. Take-off static thrust, 2,500 lb. at s.f.c. 1.11 lb./lb./hr.



DE HAVILLAND DOUBLE SPECTRE DSpe.D.1

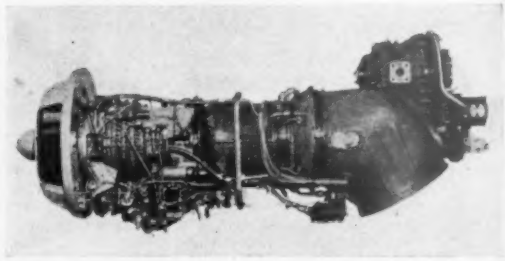
THE Double Spectre is the powerplant for Blue Steel, the Avro stand-off bomb; it consists of a fixed-thrust Spectre 4 mounted above a variable-thrust Spectre 5. The Spectre is a liquid-propellent motor which uses kerosene and HTP. Originally designed for use in piloted aircraft, such as the Saunders-Roe S.R.53, this motor has been produced in several forms and is used as an assisted take-off unit for the Victor and Vulcan bombers.

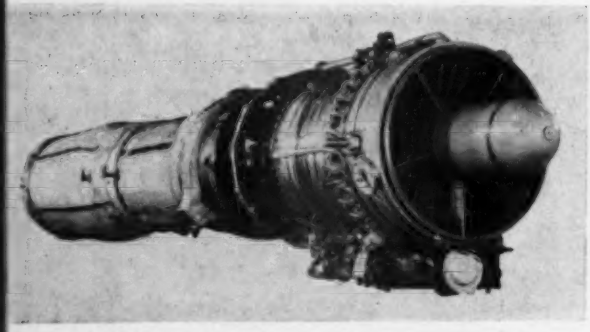
Technical Data.—Liquid-propellent rocket motor: two combustion chambers; propellents supplied by turbopumps. Overall length, 58.6 in.; width, 37.5 in.; height, 39 in. Maximum thrust, 16,000 lb. (8,000 lb. for each Spectre).

DE HAVILLAND GNOME DGe.1

THE Gnome is a licence-built version of the General Electric T-58 shaft turbine engine which is being produced by de Havilland Engines, initially as a helicopter powerplant. The first Gnome built entirely from British-manufactured components ran on June 6 this year. A turboprop version of the engine, the 1,000-s.h.p. Gnome P.1000, is also under development. De Havillands have already received Gnome orders from the Continent for engines for the Breguet 941 STOL transport and the Agusta 101G helicopter. Versions of the Westland Whirlwind and Saunders-Roe P.531 helicopters will also be Gnome-powered. The Gnome is to be up-rated to 1,250 s.h.p. and will be type-tested at this power in 1961.

Technical Data.—Shaft turbine: ten-stage compressor; annular combustion chambers; two-stage compressor turbine and single-stage free power turbine; pressure ratio 8.3:1; mass flow, 12.4 lb./sec. Length, 61 in.; width, 19.5 in.; weight without gearbox 298 lb. Take-off rating, 1,000 s.h.p. at s.f.c. of 0.67 lb./s.h.p./hr.





DE HAVILLAND GYRON JUNIOR DGJ.10

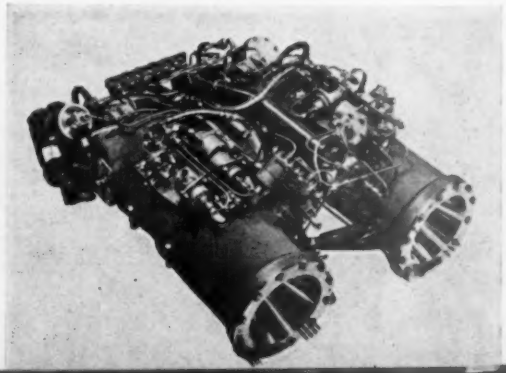
THE Gyron Junior is in production for the Blackburn N.A.39 naval strike aircraft and will also power the Bristol 188 supersonic research aircraft. The engine is a scaled-down version of the Gyron supersonic turbojet. Three versions of the Gyron Junior have been announced, the 7,000-lb.-thrust DGJ.1, the DGJ.2, which has a somewhat higher thrust, and the DGJ.10, a considerably more powerful version with an afterburner and a dry thrust of 10,000 lb. Two DGJ.10s are being installed in a testbed Javelin by Napiers at Luton.

Technical Data.—Turbojet: axial compressor (probably eight stages); annular combustion chamber; multi-stage turbine (probably two stages); reheat system designed to operate at 2,000°K. Length, 92 in.; diameter, 32.3 in. Max. dry thrust, 10,000 lb.; thrust with reheat, 14,000 lb.

NAPIER DOUBLE SCORPION NSc.D.1

THE Scorpion rocket motor is available in single, double or triple chamber form. Each chamber gives 2,500–3,000 lb. thrust. Its propellents are kerosene and HTP, which are fed to the combustion chamber or chambers by separate centrifugal pumps driven by a single-stage axial-flow turbine. In 1956 flight trials began with a Double Scorpion mounted in an English Electric Canberra; this set up an altitude record for aircraft in 1957. Current projects cover the installation of Scorpions in F-86 Sabre fighters and supersonic target missiles.

Technical Data.—Two-chamber rocket motor: length, 32 in.; width, 23 in.; thrust, 4,000–6,000 lb.



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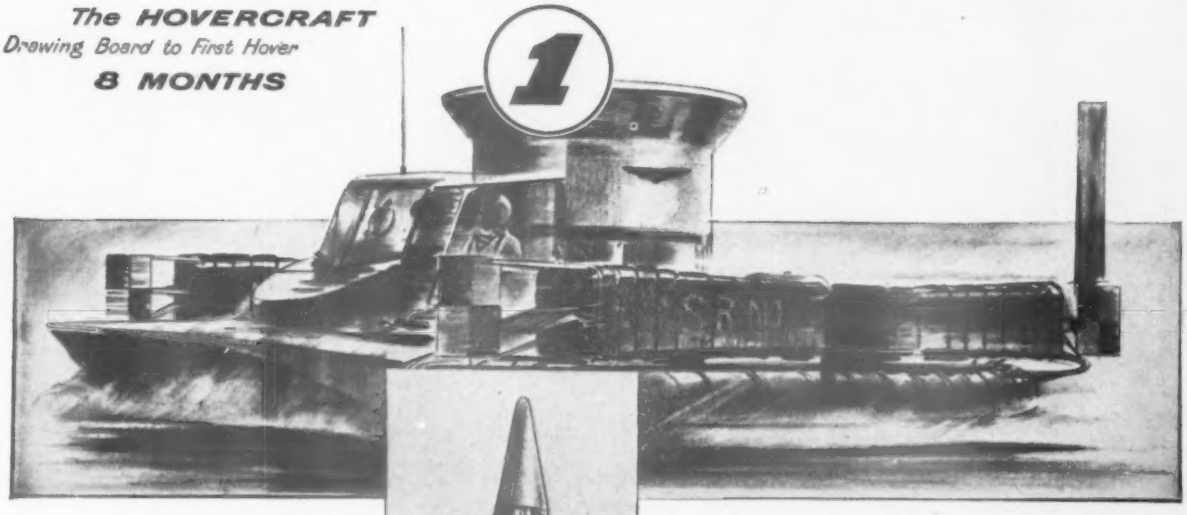
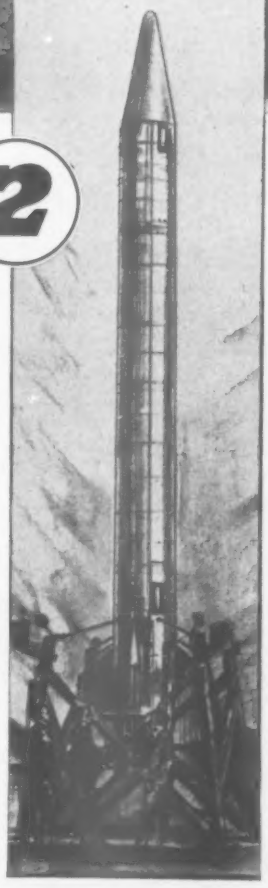
1

The **HOVERCRAFT**
Drawing Board to First Hover
8 MONTHS



2

The **BLACK KNIGHT**
Drawing Board to First Firing
2 YEARS



3

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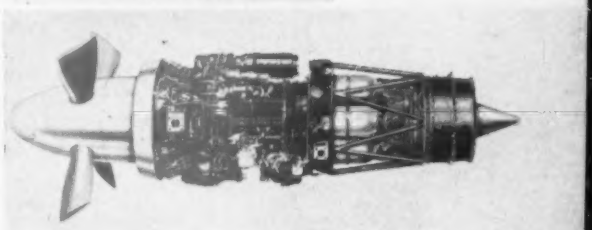
NAPIER GAZELLE NGa. 13

THE Napier Gazelle is in production for two British helicopters, the Bristol 192 and the Westland Wessex. This free-turbine engine has been designed for mounting either vertically, horizontally, or at any intermediate angle; versions can be provided with either right or left-hand rotation of the power-output shaft as applications demand.

Technical Data.—Shaft turbine: eleven-stage axial compressor; six combustion chambers; two-stage compressor turbine and single-stage free power turbine; pressure ratio, 6.37:1; mass flow, 17.5 lb./sec. Length, 70 in.; diameter, 33.5 in.; 2½-min. power rating, 1,800 s.h.p. with s.f.c. 0.664 lb./s.h.p./hr.; one-hour rating, 1,450 s.h.p. with s.f.c. 0.703 lb./s.h.p./hr.

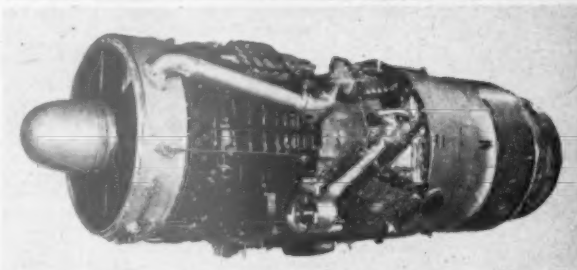
NAPIER ELAND NEl.6



ELAND NEl.6s power the Canadair 540 transport and other versions of this engine are installed in the Westland Westminster and Fairey Rotodyne helicopters. On the Rotodyne two NEl.3 Elands drive propellers during cruising flight when the rotor is autorotating; during flight as a helicopter most of the power drives auxiliary compressors which supply air to the tip-jets of the rotor. On the Westminster the rotor is driven by the Elands through a shaft drive via clutches and a gearbox. The production Westminster will have E.211 Elands with a one-hour rating of 2,650 s.h.p.

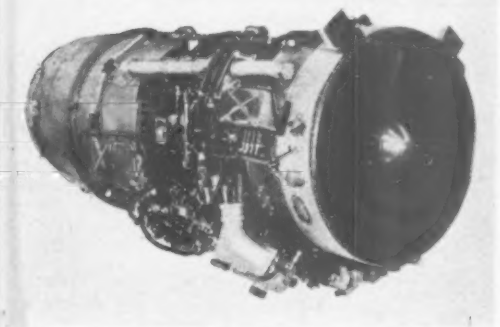
Technical Data.—Shaft turbine: ten-stage axial compressor; six combustion chambers; three-stage turbine; pressure ratio, 7:1; mass flow, 31.0 lb./sec. Length, 116 in.; diameter, 36 in.; dry weight, 1,820 lb. Max. take-off power, 3,230 s.h.p. plus 700 lb. thrust (3,500 e.h.p.) at 0.61 lb./e.h.p./hr.; max. continuous power, 2,910 e.h.p. at s.f.c. 0.63 lb./e.h.p./hr.

ROLLS-ROYCE AVON RA.29



THE RA.29 is the commercial version of the Avon engine: military Avons power the Canberra, Lightning, Valiant, Comet 2, Hunter 6, Scimitar, Swift, Fairey FD-2, Saab Draken, Saab Lansen and Commonwealth Sabre. The RA.29 is the powerplant of the de Havilland Comet 4 and the Sud-Aviation Caravelle. The latest military Avon is the RA.24 of 11,250 lb. dry thrust. The 10,500-lb.-thrust RA.29 has been developed as a civil engine with the emphasis on long life and low fuel consumption. It entered airline service on the Comet 4 in October, 1958, with an overhaul life of 1,000 hr.; this has now been increased to 1,300 hr. Later civil Avons are being developed with ratings of 11,700 and 12,500 lb. thrust.

Technical Data.—Turbojet: sixteen-stage axial compressor; eight cannular combustion chambers; three-stage turbine; pressure ratio, 9.27:1; mass flow, 173 lb./sec. Overall length, 124.8 in.; width, 41.5 in.; dry weight, 3,326 lb. Take-off thrust, 10,500 lb. at s.f.c. 0.775 lb./lb.hr.

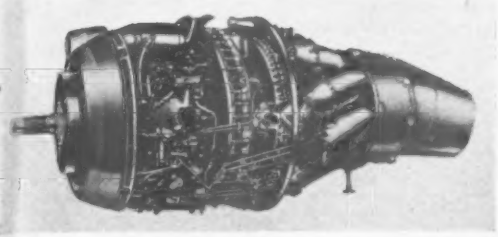


ROLLS-ROYCE CONWAY RCo.10

THE Conway is the first by-pass engine to go into production and has both military and civil applications. It is the powerplant of the Handley Page Victor B.2 bomber and of versions of the Boeing 707 and Douglas DC-8 transports. It has also been specified for the Vickers V.C. 10 transport. The military version of the engine, the R Co.11, has a dry thrust of 17,250 lb.; guaranteed minimum dry thrusts of the civil versions are respectively: R Co.10, 16,500 lb.; R Co.12, 17,500 lb.; R Co.15, 18,500 lb.

Other engines in the Rolls-Royce by-pass family are the RB.141 for later versions of the Caravelle, the RB.140 and the 10,100-lb.-thrust RB.163 for the D.H.121 airliner.

Technical Data.—Two-spool by-pass turbojet: multi-stage low-pressure and high-pressure compressors; cannular combustion system; high-pressure and low-pressure turbines. Length, 132.5 in.; diameter, 42 in.; take-off thrust, 18,500 lb. (R Co.15).



ROLLS-ROYCE DART RDa.7/2

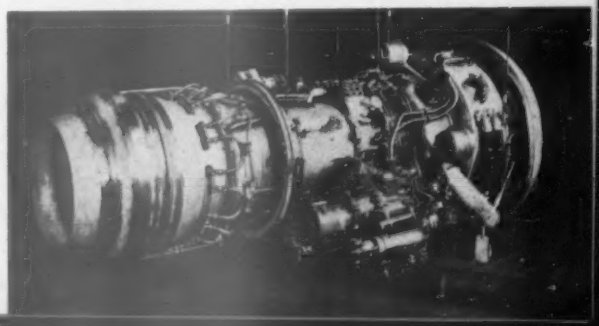
THE Dart is the classic engine which introduced turboprop air travel when B.E.A. Viscounts entered service in 1953. The engine has been extensively developed and a military version of the R Da.10 has been tested at 3,200 e.h.p.—more than double the take-off power of the first production Darts. The 1,760-s.h.p. R Da.6 powers Viscounts of the later 700 and early 800 series and the Fokker/Fairchild F-27. The 2,105-e.h.p. R Da.7 is the powerplant of later Viscounts and F-27s, the Dart Herald, Grumman Gulfstream, Argosy and Breguet Alizé anti-submarine aircraft. The civil R Da.10 delivers 2,660 e.h.p. Darts have flown more than eight million hours in airline service.

Technical Data.—Turboprop: two-stage centrifugal compressor; seven combustion chambers; three-stage turbine; pressure ratio, 5.62:1; mass flow, 32 lb./sec. Length, 97.6 in.; diameter, 37.9 in.; dry weight, 1,250 lb.; max. power, 2,100 e.h.p. at s.f.c. 0.660 lb./e.h.p./hr.

ROLLS-ROYCE TYNE RTy.11

THE two-spool Tyne is a high-efficiency turboprop engine which powers the Vickers Vanguard and Canadair CL-44 transports and has been specified for the Short Britannic military transport, the Nord 2105 maritime-reconnaissance aircraft, the Transall military transport being jointly developed by Nord Aviation and German companies, and advanced versions of the Fairey Rotodyne. The extremely low fuel consumption of the Tyne makes it comparable with the latest compound piston engines; a typical s.f.c. is 0.388 lb./e.h.p./hr. when cruising at 425 m.p.h. at 25,000 ft. in I.S.A. conditions. Initial delivery ratings of the Tyne are: R Ty.1, 4,985 e.h.p.; R Ty.11, 5,525 e.h.p.; R Ty.12, 5,730 e.h.p. The illustration shows the R Ty.1.

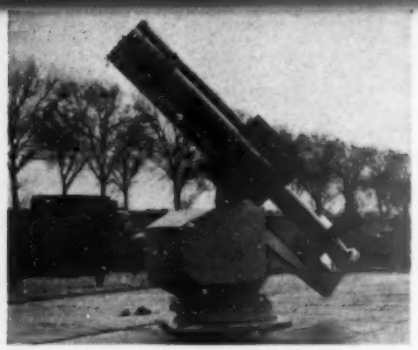
Technical Data.—Two-spool turboprop: multi-stage low-pressure and high-pressure axial compressors; cannular combustion system; single-stage low-pressure and three-stage high-pressure turbines; pressure ratio, 13:1. Length, 100.25 in.; diameter, 40.5 in.; dry weight, 2,200 lb. (R Ty.1); take-off power, 5,030 s.h.p. plus 1,240 lb. thrust (5,525 e.h.p.) and s.f.c. 0.48 lb./e.h.p./hr.



ARMSTRONG WHITWORTH SEASLUG (SAM)

DESIGNED to engage enemy bombers which evade the fighter defences of the Fleet, Seaslug will arm the Royal Navy's four new "Hampshire"-class escort destroyers. The missile is fired from a triple launcher fed automatically from a magazine below decks; the launching platform is gyro-stabilized against ship roll. A beam-riding missile, Seaslug has cruciform wings and is controlled by four hydraulically operated moving tail fins. Four wrapped boosters supply take-off thrust, and the missile employs an I.C.I. solid-propellent sustainer. Main contractors for guidance and control equipment are G.E.C. and Sperry.

Technical Data.—Length, 20 ft.; max. dia., 18 in.; wing span, 5 ft. 3 in.; boost length, 12 ft. (These figures have been estimated.) Weight and performance information is classified.



Seaslug

AVRO BLUE STEEL (ASM)

INTENDED as primary armament for the Vulcan and Victor bombers, Blue Steel has a canard configuration, with moving delta foreplanes and rear-mounted delta wings. Carried partially within the bomb-bay of the parent aircraft, the missile has a ventral fin which folds to provide ground clearance at take-off. The de Havilland Double Spectre rocket engine gives a total of about 16,000 lb. s.t. Guidance is an inertial system developed by Elliott Bros. (London), Ltd., in conjunction with the R.A.E.

Technical Data.—Length, 36 ft.; max. dia., 60 in.; wing span, 16 ft. (These figures have been estimated.) Performance details classified, but probably intended to cruise at supersonic speed at heights of up to 60,000 ft. after release some 400 miles from target.

Blue Streak

BRISTOL BLOODHOUND (SAM)

A surface-to-air missile of outstanding range, Bloodhound is in production for the Royal Air Force; it first became operational with No. 264 Squadron of R.A.F. Fighter Command at North Coates, Lincs. Designed with mobility and ease of handling firmly in mind, the missile is fired from a zero-length launcher by four solid-propellent boost rockets which jettison; cruise performance is supplied by twin 16-in. Bristol Siddeley Thor ramjets.

Guidance, by Ferranti, is semi-active radar homing, acting on pivoted wings which can move differentially or together. The target is illuminated by powerful signals from a B.T.H. Sting Ray ground radar and the missile acts upon the target reflections.

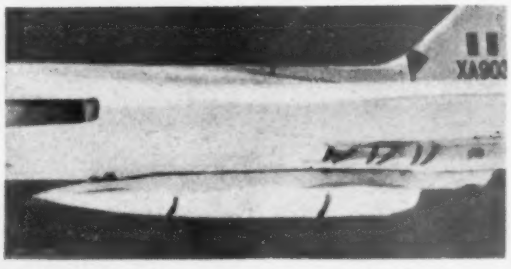
Bloodhound has been ordered for the Royal Swedish Air Force, and a developed version with greater lethality and increased range and altitude has also been ordered by the R.A.F.

Technical Data.—Length, 22 ft. 2 in.; max. dia., 21 in.; wing span, 9 ft. 3 in.; boost length, 12 ft. Performance details classified, but speed at altitude believed to be about Mach 2.5, slant range probably at least 60 miles.

DE HAVILLAND FIRESTREAK (AAM)

THIS potent airborne missile will form the primary armament of Britain's "last generation" fighters, two being carried by the Lightning P.1B and four each by the Javelin FAW. 7 and 8 and Sea Vixen FAW. 1. Firestreak-equipped Sea Vixens are now in squadron service with the Fleet Air Arm. The missile has cruciform fixed wings and cruciform moving fins, and is propelled by an integral solid rocket. Guidance is by infra-red homing, the heat-sensitive cell for which is mounted behind eight optically flat nose panels. An infra-red proximity fuse is fitted.

Technical Data.—Length, 10 ft. 5½ in.; max. dia., 8½ in.; wing span, 2 ft. 5½ in. Weight and performance information classified.



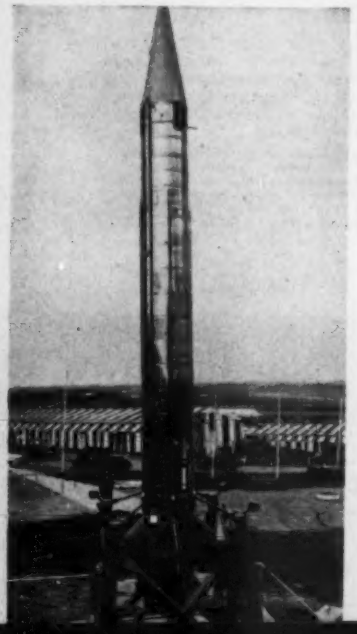
Blue Steel

D.H. PROPELLERS BLUE STREAK (SSM)

UNDER development for R.A.F. Bomber Command, Blue Streak is officially described as a Long Range Ballistic Missile, and is clearly superior to the imported Thor IRBM which it will eventually replace. Testing is expected to begin early next year at Woomera, after ground-running trials of the twin-chamber propulsion unit at Spadeadam in Cumberland.

Propulsion system contractor is Rolls-Royce, who have a licence agreement with North American Rocketdyne to develop the LR-79 standard gimballed engine used in the Thor IRBM. Airframes are being built by the de Havilland Aircraft Co., with guidance in the hands of Sperry. In operation, Blue Streak is intended to be launched from underground bombproof sites.

Technical Data.—Length, 70 ft.; max. dia., 120 in.; launch weight, 200,000 lb. approx.; range, 2,800 miles plus. Propulsion: 2×135,000 lb. s.t. rocket engines employing liquid oxygen/kerosene. Guidance: inertial. (All figures, except length and diameter, have been estimated.)



Black Knight

ENGLISH ELECTRIC THUNDERBIRD (SAM)

ORIGINALLY intended for use by the Army, Thunderbird has also been ordered by the R.A.F. The missile is fired from a zero-length launcher and is controlled in flight by cruciform fixed wings and moving tail surfaces. Four wrapped boosters jettison within seconds of launching, and sustained flight is provided by an integral solid rocket motor.

Guidance, by Marconi, is of the semi-active homing type, being responsive to reflections from the same target-illuminating radar as Bloodhound. An advanced version making use of improvements in propulsion and guidance is under development.

Technical Data.—Length, 18 ft. 10½ in.; max. dia., 20½ in.; wing span, 5 ft. 6½ in.; boost length, 12 ft. Weight and performance figures classified, but slant range probably exceeds 20 miles.

SAUNDERS-ROE BLACK KNIGHT (RTV)

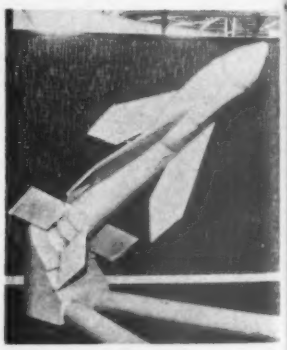
DESIGNED as a re-entry test-vehicle for the Blue Streak programme, Black Knight has ascended to heights of 300, 350 and 500 miles in recent test firings at Woomera. A second-stage solid propellent rocket is now being developed to increase the velocity potential.

Technical data.—Length, 35 ft.; max. dia., 36 in. Propulsion: 4×4,000 lb. s.t. Bristol Siddeley Gamma rocket engines employing HTP/kerosene.' Guidance: elementary pitch programmer.

SHORT SEACAT (SAM)

A surface-to-air missile, the Seacat is designed to replace the 40-mm. Bofors gun as a short-range Naval A.A. weapon. This diminutive missile, little more than 4 ft. long, employs a two-stage solid-propellent motor and can be handled easily by two men. It is subsonic with cruciform moving wings and cruciform fixed fins. Guidance is apparently by radio-command. A land-based version, the Tigercat, is being developed by Shorts as a private venture.

Technical Data.—Length, 4 ft. 6 in.; max. dia., 9 in.; wing span, 1 ft. 9 in. (These figures have been estimated.)



Seacat

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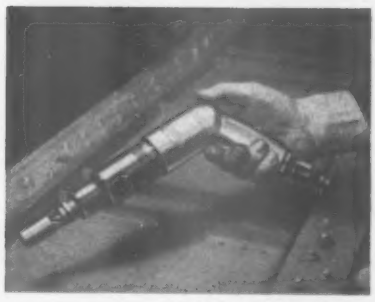
The Mighty Atom Corner Drill reaches any awkward spot. This M2 model is being used on the engine mounting of a Vickers Viscount. *Photograph by courtesy of Vickers-Armstrongs.*

A Desoutter Rackfeed Drill reaming holes in the centre section of an Avro Vulcan bomber. *Photograph by courtesy of A. V. Roe & Co. Ltd.*



Another widely used tool in the aircraft industry is this Desoutter Bolt Miller.

Drilling and countersinking rivet holes with Desoutter power tools on the fuselage skin of a Vickers Vanguard. *Photograph by courtesy of Vickers-Armstrongs.*

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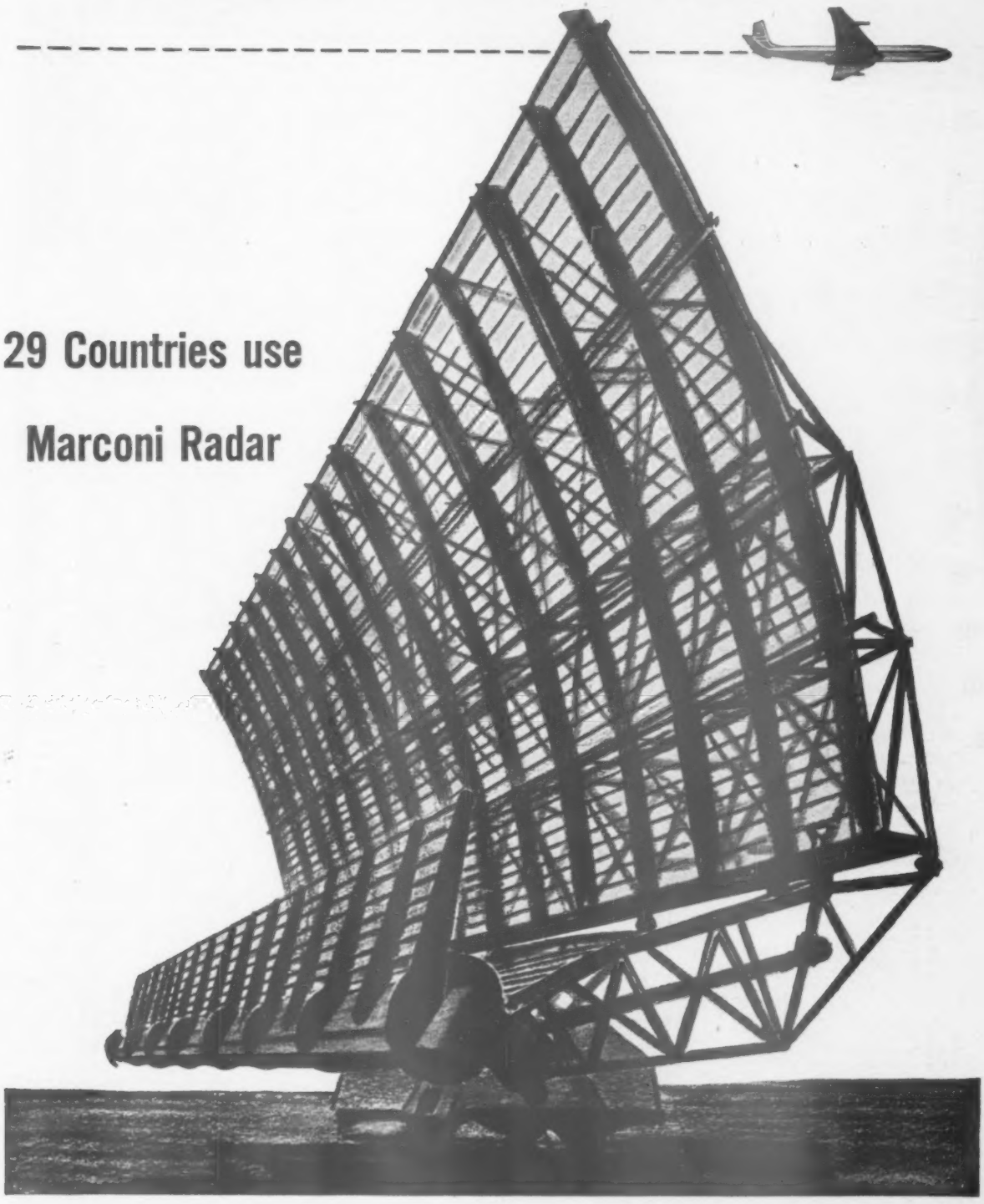
Marconi in Radar



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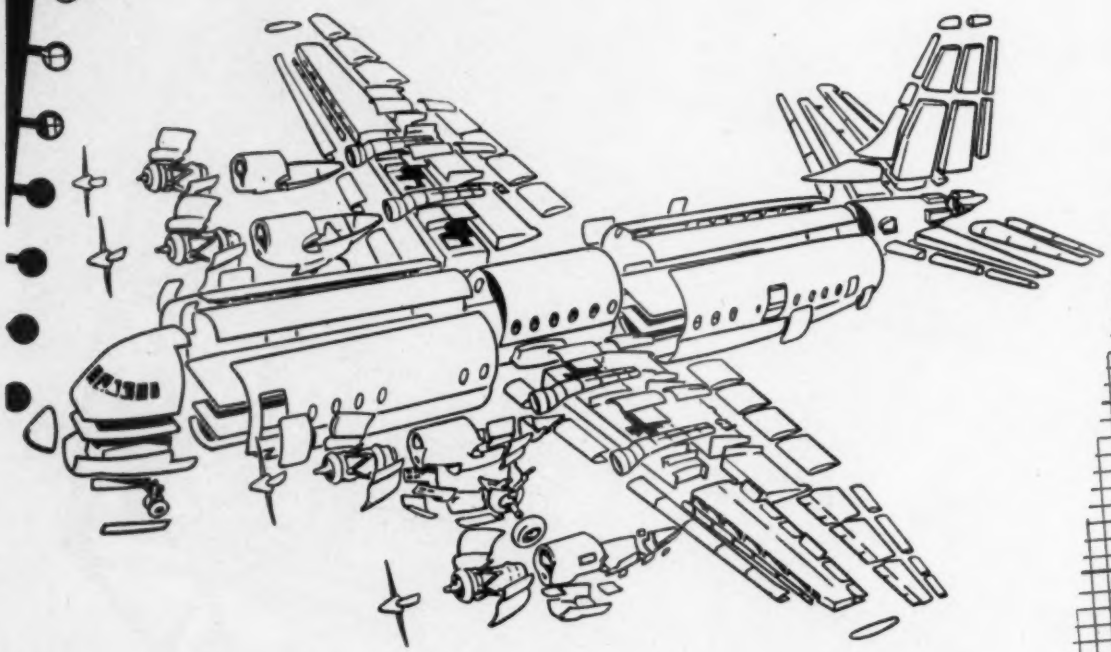
VANGUARD STRUCTURAL DRAWING



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1 — *Basic Metallic Materials*

Aeroplane and Motor Aluminium Castings, Ltd., Wood Lane, Erdington, Birmingham. T.: Erdington 2207-9. Pressure, gravity and sand castings.

Aircraft Engineering and Jigs, Ltd., Wren Works, Chadderton, Lancs. T.: Chadderton 5691. Ferrous and non-ferrous castings.

Albion Drop Forgings Co., Ltd., Foleshill, Coventry. T.: Coventry 88091-3. Forgings, stampings.

Aluminium Corporation, Ltd., 30 Charles II Street, London, S.W.1. T.: Trafalgar 3104. Aluminium sheets, strip and circles.

Andrews Toledo, Ltd., Toledo Steelworks, Sheffield, 3. T.: Sheffield 23274. Aircraft steels.

Balfour, Arthur, and Co., Ltd., Capital Steel Works, Sheffield, 3. T.: Sheffield 22071. High-speed, alloy tool and plain carbon tool steels.

Birkett, T. M., Billington and Newton, Ltd., Birkett St., Hanley, Stoke-on-Trent. T.: Stoke-on-Trent 22184. Non-ferrous castings and machine parts; Birso chill-cast rods and tubes.

Bolton, Thomas, and Sons, Ltd., Mersey Copper Works, Widnes, Lancs. T.: Widnes 2022. Suppliers of copper, brass and bronze.

Brunah, J. R., and Co., Ltd., Devonshire St., Sheffield, 3. T.: Sheffield 24228. Aluminium alloy; Nimonic, etc., fabrications; Argon welding, etc.

Britannia Tube Co., Ltd., The, Glover St., Birmingham. Aluminium and alloy tubes and sections.

Carlisle, C. G., and Co., Ltd., Iona Steel Works, 629 Penistone Rd., Sheffield, 6. T.: Sheffield 348791 and 43796. Stainless-steel bars.

Clifford, Charles, Ltd., Dogpool Mills, Birmingham, 30. T.: Selly Oak 1544. Non-ferrous metals. Phosphor-bronze, aluminium bronze. Brass and copper sheet and strip, tubes, etc.

Coley, R. J., and Son (Hounslow), Ltd., Jubilee Works, Chapel Rd., Hounslow, Middx. T.: Hounslow 2266. Metal merchants.

Dale, John, Ltd., London Colney, Herts. T.: Bowmansgreen 2266. Aluminium alloy castings.

Darwins, Ltd., Fitzwilliam Works, Tinsley, Sheffield, 9. T.: Sheffield 49049. Aircraft steels and machine tools. Alloy castings, etc.; alloy tool and high-speed steel.

Deritend Stamping Co., Ltd., Liverpool St., Deritend, Birmingham, 9. T.: Victoria 2941-5. Forgings and stampings.

Diecastings, Ltd., Highgate Sq., Birmingham, 12. T.: Calthorpe 2241-3. Gravity, die and sand castings.

Doncaster, Daniel, and Sons, Ltd., 284 Penistone Rd., Sheffield, 6. T.: Sheffield 43081. Forgings; turbine blades, etc.

Dudley Drop Forging Co., Ltd., Holly Hall, Dudley, Worcs. T.: Brierley Hill 77561. Forgings in steel, titanium, Nimonic, aluminium, phosphor-bronze.

Equator Wheels and Sections, Ltd., Raglan St., Wolverhampton. T.: Wolverhampton 21605. Stainless-steel stiffening bands. Cold rolling, forming, profiles, etc.

Fry's Metal Foundries, Ltd., Tandem Works, Merton Abbey, London, S.W.19. T.: Mitcham 4023. Solders and fluxes; Fryolux solder paint.

Kayser, Ellison and Co., Ltd., Carlisle Steel Works, G.P.O. Box 144, Sheffield, 4. T.: Sheffield 22124. High-speed steels, carbon and alloy tool steels, stainless steels, etc.

Kiveton Park Steel and Wire Works, Ltd., Kiveton Park, nr. Sheffield. T.: Kiveton 252. Steel bars.

Langley Alloys, Ltd., Langley, Slough, Bucks. T.: Langley 432. Hidurel high-conductivity alloys; Hidurax aluminium bronzes.

Lavender, J. H., and Co., Ltd., Hall Green Works, Cranknall Lane, West Bromwich. T.: Stone Cross 2273. Aluminium alloy castings.

Lee, Arthur, and Sons, Ltd., Trubrite Steel Works, Meadow Hall, nr. Sheffield. Bars, strip, etc.

Light-metal Forgings, Ltd., Churchbridge, Oldbury, nr. Birmingham. T.: Broadwell 1152 and 1895. Drop forgings and stampings.

Low Moor Alloy Steel Works, Ltd., The Steel Works, Low Moor, Bradford, Yorks. T.: Bradford 77331. Stainless steels.

Manganese Bronze and Brass Co., Ltd., The, 2 London Wall, London, E.C.2. T.: London Wall 8802. Wrought metals.

Mills, Exors. of James, Ltd., Bredbury St. Works, Woodley, nr. Stockport. Ledloy free-cutting steel, etc.

Mills, William, Ltd., Friar Park Rd., Wednesbury, Staffs. T.: Stonecross 2276-7-8. Aluminium and magnesium alloy castings, etc.

Mining and Chemical Products, Ltd., 86 Strand, London, W.C.2. T.: Covent Garden 3393. Cerromatrix and Cerrotru fusible alloys; Cerrobend; MCP 15 Alloy.

Morgan, George, Ltd., Grange Rd., Selly Oak, Birmingham, 29. T.: Selly Oak 1156. Drop forgings.

Nitralloy, Ltd., Atlas Works, Sheffield, 4. T.: Sheffield 26646. Nitriding process of case-hardening special steels and Nitralloy steels.

Omes, Ltd., Beverley Works, Barnes, London, S.W.13. T.: Prospect 2291, and Poyle, Colnbrook, Bucks. Compressor and turbine-blade forgings, etc.

Osborn, Samuel, and Co., Ltd., Clyde Steel Works, Sheffield. Aircraft steels.

Perry Barr Metal Co., Ltd., Oscott and Queslett Works, Shady Lane, Gt. Barr, Birmingham, 22a. T.: Gt. Barr 1794. Light alloys.

Rapp, Leo, Ltd. (inc. LR Airsteel, Ltd.), Wimborne Av., Norwood Green, Southall, Middx. T.: Southall 2322. Aluminium and aluminium-alloy sheet, bar, tube, etc.; stainless carbon and alloy steels to all specifications.

Rapp, Leo (Steel), Ltd., Wimborne Av., Norwood Green, Southall, Middx. T.: Southall 2322. Mild steel, sheets, plates and sections. Steels for jigging and tooling.

Renfrew Foundries, Ltd., Hillington, Glasgow, S.W.2. T.: Halfway 3391. Alminal castings.

Rollet, H., and Co., Ltd., 6 Chesham Place, London, S.W.1. T.: Sloane 3463. Non-ferrous materials.

Samlesbury Engineering, Ltd., Samlesbury Airfield, nr. Blackburn, Lancs. T.: Blackburn 44668. Steel extrusions.

Sheepbridge Alloy Castings, Ltd., Hamilton Rd., Sutton-in-Ashfield, Notts. T.: Sutton-in-Ashfield 590. Alloy steel castings.

Sheffield Forge and Rolling Mills, Ltd., Millsands, Sheffield, 3. Aircraft steels.

Smethwick Drop Forgings, Ltd., Rolfe St., Smethwick. T.: Smethwick 1234. Drop forgings.

Smith-Clayton Forge, Ltd., Tower Works, Lincoln. T.: Lincoln 25492. Forgings and drop stampings.

Steel Stampings, Ltd., Cooksley, nr. Kidderminster. T.: Wolverley 266. Pressings in stainless steel and other metals; welded rings.

Titanium Metal and Alloys, Ltd., 2 Metal Exchange Buildings, Leadenhall Avenue, London, E.C.3. T.: Mansion House 4521; and Clyde Steel Works, Sheffield, 2. Titanium rolled bar, forged blanks, rings and sheets.

United Steel Companies, Ltd., The, 17 Westbourne Rd., Sheffield, 10. T.: Sheffield 60081; and 8 Grosvenor Gardens, London, S.W.1. T.: Sloane 4533. Iron and steel plates, sections, forgings; alloy and special steels.

Vaughan Bros. (Drop Forgings), Ltd., Eagle Works, Willenhall, Staffs. T.: Willenhall 436-8. Drop forgings.

Wilson, W., and Sons (London), Ltd., 1-3 Chalfont Rd., London, N.7. Aluminium and aluminium alloys.

Yorkshire Engineering Supplies, Ltd., Upper Wortley Rd., Wortley, Leeds, 12. T.: Leeds 638234 and 638291. Estonia and E.C.C. castings, etc.

Yorkshire Imperial Metals, Ltd., The, P.O. Box 166, Stourton, Leeds. T.: Leeds 72222. Solid-drawn tubes. Yorkshire capillary fittings; Polyork plastic tube.

Young, A. S., and Co., Ltd., Tower Works, Woodside Lane, London, N.12. T.: Hillside 6606-7. Welding rods and Colmonoy hard-surfacing alloys. Nicrobraz high-temperature brazing alloy.

2 — *Non-metallic Materials*

British Moulded Plastics, Ltd., Avenue Works, Walthamstow Av., London, E.4. T.: Larkswood 2323. Telenduron bitumen asbestos compound and mouldings; moulded plastics and extrusions.

B.X. Plastics, Ltd., Higham Station Av., London, E.4. T.: Larkswood 5511. Sheets, rods, tubes, extrusions, foil, etc., in Cobex, Bexoid, Xylonite, B.X. P.V.C., B.X. Polystyrene, and Isoflex (thermal insulation).

Cape Asbestos Co., Ltd., 114 Park St., London, W.1. T.: Grosvenor 6022. Insulating materials, linings; building and insulation boards.

Cork Manufacturing Co., Ltd., Hall Lane, South Chingford, London, E.4. T.: Silverthorn 1101. Langite and Neolangite jointings and packings.

Daleman, Richard, Ltd., 325-327 Latimer Rd., London, W.10. T.: Ladbroke 3709. Evolite Perspex (acrylic) tubes and cylinders.

Expanded Rubber Co., Ltd., Mitcham Rd., Croydon, Surrey. Onazote expanded acylonitrile for radomes; Rubazote soft expanded rubber.

Ferodo, Ltd., Chapel-en-le-Frith, Stockport. T.: Chapel-en-le-Frith 2520. Friction materials.

Gosheron, John, and Co., Ltd., Packaging and Industrial Tape Centre, Albert Embankment, London, S.E.11. T.: Reliance 7600-9. Self-adhesive tapes.

Jones, Samuel, and Co., Ltd., New Bridge St., London, E.C.4. T.: Central 6500. Self-adhesive tapes.

Kautex, Ltd., Elstree Way, Elstree, Herts. T.: Elstree 1777-9. Neo-K-Tex jointings; anti-vibration and insulation packings.

Leicester, Lovell and Co., Ltd., North Baddesley, Southampton, Hants. T.: Rownhams 363. Casco synthetic resins and Casein glues.

Mallinson, William, and Sons, Ltd., 130-150 Hackney Rd., London, E.2. T.: Shoreditch 7654. Hardwoods, veneers, plywoods, etc.

Mandleberg, J., and Co., Ltd., Albion Works, Cobden St., Pendleton, Salford 6, Lancs. T.: Pendleton 1441. Proofed fabrics for balloons, dinghies, flotation gear, inflatable chairs, aircraft covers, etc.

Minnesota Mining and Manufacturing Co., Ltd., 3M House, Wigmore St., London, W.1. Scotch Boy cellulose and masking tapes, 3M adhesive coatings and sealers; 3M coated abrasives.

Morgan Crucible Co., Ltd., The, Battersea Church Rd., Battersea, London, S.W.11. T.: Battersea 8822. Morganite carbon and metal-graphite brushes and contacts. Carbon piles and electrodes.

Moulded Components (Jablo), Ltd., Mill Lane, Croydon, Surrey. T.: Croydon 2201. Airscrew and helicopter blades, etc. Sandwich panels with Aero Jablex core; glass-fabric facings; thermal and sound insulation.

Nobrac Carbon, Ltd., Commerce Way, Lancing, Sussex. T.: Lancing 2053. Specialist grade carbons.

North British Plastics, Ltd., Patterson St., Blaydon-on-Tyne. T.: Blaydon 346-9. Panax paper-base laminated sheets, etc.

Peradin Rubber, Ltd., Freshford, nr. Bath, Somerset. T.: Limpley Stoke 3263. Peratol sealing compound.

Rubbaglas, Ltd., 66 Victoria St., London, S.W.1. T.: Victoria 6501. Rubbaglex sheeting, etc.

Scott, Bader and Co., Ltd., Wollaston, Wellingborough, Northants. T.: Wollaston 262. Marco and Crystic polyester resins.

Trade Directory . . . .

Smith and Nephew, Ltd., Bessemer Rd., Welwyn Garden City, Herts. T.: Welwyn Garden City 5151. Lasso self-adhesive tapes.

Sorbo, Ltd., Woking, Surrey. T.: Woking 966. Rubber goods.

Surridge's Patents, Ltd., New Works, Croydon Rd., Elmers End, Beckenham, Kent. T.: Beckenham 0168 and 1313. Holdtite adhesives.

Tinkertex, Ltd., Bottoms Mill, Holmfirth, nr. Huddersfield. T.: Holmfirth 636. Aircraft upholstery cloth and curtaining. Uniform cloths.

Wallington, Weston and Co., Ltd. (Inc. Frome Plastics, Ltd.), Vallis Mills, Frome, Somerset. T.: Frome 2206. Hibudine seals and gaskets. Fromoplas plastics sheets, mouldings and moulding powder. Flexlite sponge rubber.

Warerite, Ltd. (unit of Bakelite, Ltd.), Watton Rd., Ware, Herts. Decorative laminated plastics.

Wright, John, and Sons (Veneers), Ltd., Avon Wharf, Longfellow Rd., Mile End Rd., London, E.3. T.: Advance 4444. British-cut veneers for construction and decoration.

3 — Prefabricated Components and Parts

Abbey Panel and Sheet Metal Co., Ltd., Old Church Rd., Coventry. T.: Coventry 89461. Aircraft fabrications, cowls and assemblies.

Aerocontacts, Ltd., Gatwick Airport, Horley, Surrey. T.: Horley 1510. A.G.S. parts, accessories and components.

Aerolex, Ltd., Bridge Rd., Camberley, Surrey. T.: Camberley 1500. Components and assemblies.

Aeroparts Engineering Co., Ltd., Commercial Rd., Hereford. T.: Hereford 3068. Assemblies and components; lubrication equipment and tools.

Aircraft Engineering and Jigs, Ltd., Wren Works, Chadderton, Lancs. T.: Chadderton 5691. Aircraft components.

Aircraft-Marine Products (Gt. Britain), Ltd., 60 Kingly St., London, W.1. T.: Regent 2517-8. Solderless terminals and connectors; precision crimping.

Amal, Ltd., Holdford Rd., Witton, Birmingham, 6. T.: Birchfields 4571. Flame traps, fuel filters, fuel lift pumps, valves, cowling fasteners.

Angus, George, and Co., Ltd., Angus House, Newcastle upon Tyne, 1. T.: Newcastle upon Tyne 22656-9. Gaco oil seals, hydraulic packings and mouldings, brake and clutch linings, gears, fire extinguishers, fire hose, transmission and conveyor belting.

Arens Controls, Ltd., Trowers Way, Holmethorpe, Redhill, Surrey. T.: Redhill 5511-3. Remote controlling gear; operating boxes; end fittings.

Armstrong Patents Co., Ltd., Eastgate, Beverley, Yorks. Heli-coil screw thread inserts and high-endurance nuts.

Aston, E. S., and Co., Ltd., 5 Sebastian St., Goswell Rd., London, E.C.1. T.: Clerkenwell 2179. Instrument panels cleats; fairleads; packings and control knobs in laminated plastics and cast resins.

Autoset (Production), Ltd., Stour St., Birmingham, 18. T.: Edgbaston 1143-4. Springs and rubber-suspension equalizing castors; fixed-direction wheel brackets; castors.

Avery Equipment, Ltd., Tachbrook Rd., Leamington Spa. T.: Leamington Spa 2700. Flexible hose and self-sealing couplings.

Aviation Traders, Ltd., 21 Wigmore St., London, W.1. T.: Museum 7791; Southend Airport, Essex. T.: Rochford 56491; and Stansted Airport, Essex. T.: Takeley 391. A.G.S. parts major and sub-airframe assemblies; gas-turbine sheet-metalwork; tubular fabrications.

Barber and Colman, Ltd., Marstand Rd., Brooklands, Manchester. T.: Sale 2277. Shakeproof thread-cutting screws; lock washers.

Baxter's (Bolts, Screws and Rivets), Ltd., Parade Works, Sheepcote St., Birmingham, 15. T.: Midland 0105. Bolts and rivets.

Beckett, Laycock and Watkinson, Ltd., Acton Lane, Harlesden, London, N.W.10. T.: Elgar 5403. Glazed assemblies, Beclawat silent window channel.

B.M.B. (Sales), Ltd., High St., Crawley, Sussex. Steel bearings and balls. Miniature bearings.

Borg and Beck Co., Ltd., Tachbrook Rd., Leamington Spa. T.: Leamington 2700. Clutches.

Bramah, J. R., and Co., Ltd., Devonshire St., Sheffield, 3. T.: Sheffield 24228. Aircraft tanks.

Brauer, F., Ltd., Grove Road, Harpenden, Herts. T.: Harpenden 3603. Toggle clamps.

British Tyre and Rubber Co., Ltd., Herga House, Vincent Sq., London, S.W.1. T.: Victoria 3848. Rubber de-icing, seals, etc.

British Wire Products, Ltd., Worcester Rd., Stourport-on-Severn, Worcs. T.: Stourport 240. Controls and cables; Britloc wire rope slings, oil filters, pipe-bending, etc.

Brown, David, Ltd., London Gear Division, Stonebridge Park Works, North Circular Rd., London, N.W.10. T.: Elgar 6824. Gears and gear units; Radicorn worm reducers; gear pumps.

Brown, E. G., and Co., Ltd., West Rd., Northumberland Park, Tottenham, London, N.17. T.: Tottenham 2257. Fuel and oil tanks, pilots' seats, tailplane assemblies and elevators, cowlings, pressings and stampings, etc.

Burnley Aircraft Products, Ltd., Fulledge Works, Holmes St., Burnley. T.: Burnley 3121-2 and 3203. Wing flaps, bomb doors and hatches, jettison tanks. Sheet metal and welded steel components.

Carr Fastener Co., Ltd., Stapleford, Nottingham. T.: Sandiacre 3085. Fasteners.

Cathodeon, Ltd., Church St., Cambridge. T.: Cambridge 56481. Hermetic glass - to - metal seals. Vacuum tubes and high-voltage vacuum relays.

Clayton-Wright, Howard, Ltd., Wellesbourne, Warwickshire. T.: Wellesbourne 316-7-8. Clatonrite self-sealing weatherstrip; Nylastic adjustable cable and Clatonrite anti-vibro cable support clips; Harrisflex anti-vibration mountings; Clayflex flexible bearings; Nylastic bearings; Clatonrite Stikastrip.

Corner, G., and Co., Ltd., Johnson Brook Rd., Hyde, Cheshire. T.: Hyde 3493. Sheet metal assemblies.

Coventry Climax Engines, Ltd., Widdrington Rd. Works, Coventry. T.: Coventry 62607. Accessories.

Crane Packing, Ltd., Slough, Bucks. T.: Slough 24031. Band packings and mechanical seals. Processors and fabricators of P.T.F.E. plastic.

Cross Manufacturing Co. (1938), Ltd., 33 Midford Rd., Combe Down, Bath. T.: Combe Down 2355. Spring washers, labyrinth seals, wire-thread inserts, springs, etc.

Curd Components, Ltd., 41 Lonsdale Rd., London, W.11. T.: Bayswater 0319 and 6866. Standard aircraft parts.

Davis and Timmins (Aircraft), Ltd., Billet Rd., Walthamstow, London, E.17. T.: Ilford 3460. A.G.S., B.S.S. and A.S. parts.

Equator Wheels and Sections, Ltd., Raglan St., Wolverhampton. T.: Wolverhampton 21605-6. Stainless steel stiffening bands for jet engines; cold rolling, forming and coiling in all metals; profile manipulations.

Fischer Bearings Co., Ltd., Upper Villiers St., Wolverhampton. T.: Wolverhampton 26101-8. Ball and parallel roller bearings.

Fletcher, C. W. and Sons, Ltd., Sterling Works, Arundel St., Sheffield, 1. T.: Sheffield 28049 and 28040. Precision sheet-metal work.

Flexello Castors and Wheels, Ltd., Trading Estate, Slough, Bucks. T.: Slough 24121. Wheels, castors and bearings.

Flexibox, Ltd., Nash Rd., Trafford Park, Manchester, 17. T.: Trafford Park 1477. Mechanical seals. Precision lapping machines.

Fox, C. J., and Sons, Ltd., 117 Victoria St., London, S.W.1. T.: Victoria 0204-5, 5735-6. Kaylock self-locking nuts and fasteners.

Hardy Spicer, Ltd., Chester Rd., Erdington, Birmingham, 24. T.: Erdington 2191. Universal joints and cardan shafts.

Harper, C. F., Aircraft Co., Ltd., Exeter Airport, Clyst Honiton, Devon. T.: Exeter 67451. Components and sub-assemblies.

Henderson Safety Tank Co., Ltd., The, Elstree Way, Borehamwood, Herts. T.: Elstree 1758-9 and 1917. Tanks; sections and turned parts.

Heston Aircraft and Associated Engineers, Ltd., Heston Airport, Hounslow, Middx. T.: Hayes 38441. Sub-assemblies and components; S.B.A.C. filler caps.

Hobourn Aero Components, Ltd., Strood, Rochester, Kent. T.: Strood 7626. Airframe and engine machined components.

Hoffmann Manufacturing Co., Ltd., The, New St., Chelmsford, Essex. T.: Chelmsford 3151. Bearings for aircraft controls, helicopter rotor-heads, variable-pitch propellers, etc.

Jack, E. J., Ltd., 154 Camden High St., London, N.W.1. T.: Gulliver 5761. Fafnir and other American ball and roller bearings.

Lawrence, J. W., Ltd., Abbey Lane, Leicester. T.: Leicester 62441. Radiators, oil coolers and heat exchangers.

Linread, Ltd., P.O. Box 21, Cox St., Birmingham, 3. T.: Central 3951. Fasteners, bolts, screws and rivets. Special cold-forged products.

M.B. Metals, Ltd., Vale Works, Vale Rd., Portslade, Sussex. T.: Hove 48623-4. Plugs and sockets, switches, lamps, suppressors, moulded connectors.

Metalastik, Ltd., Evington Valley Rd., Leicester. T.: Leicester 37281. Rubber-to-metal weld anti-vibration devices; engine-mounting systems; mountings; couplings, undercarriage suspension, etc.

Middleton Sheet Metal Co., Ltd., Spring Vale Works, Middleton, Manchester. T.: Middleton 2427-8 Resistance welding, aircraft control surfaces, access doors, etc. Jet-engine canware; tanks and containers; glass-fibre p'astic moulding.

Midland Aeroquipment, Ltd., Park Rd., Bloxwich, nr. Walsall, Staffs. T.: Bloxwich 66414. Aircraft locks and fastenings.

Moore's (Bournemouth), Ltd., Wallisdown Rd., Bournemouth. T.: Winton 5810. High-precision machining prototype and assembly work; aircraft fabrications.

Mountford, Fredk. (Birminghams), Ltd., Fremo Works, Moseley St., Birmingham. T.: Midland 7984. A.G.S. parts; pins, etc.

Newton, L. H., and Co., Ltd., Nechells, Birmingham, 7. T.: East 1551. Special precision components, Bolts, nuts, screws, rivets and washers. Capstan and automatic work. Light pressings; bent wire work; cold forged special work in all metals.

Nobrac Carbon, Ltd., Commerce Way, Lancing, Sussex. T.: Lancing 2053. Carbon brush seals; high-altitude brushes.

Northey Rotary Compressors, Ltd., Alder Rd., Parkstone, Dorset. T.: Parkstone 4900-1. Exhausters for high-altitude instrument testing. Gas boosters for experimental process plant.

Oddie Fasteners, Ltd., Portswood Rd., Southampton. T.: Southampton 55883. Oddie fasteners, quick-release pins.

Opperman, S. E., Ltd., Stuart Works, Stirling Corner, Borehamwood, Herts. T.: Elstree 2021. Aircraft components, gears and gearing, motor units and materials.

Parkes, L. B., and Co., 16 Station St., Walsall. T.: Walsall 4546. Anodizing and metal finishing; pressings and stampings. Crash and fire-proofing petrol and oil tanks.

Peradin Rubber, Ltd., Freshford, nr. Bath, Somerset. T.: Limpley Stole 3263. Precision moulded parts and bonded rubber-to-metal parts.

Power Flexible Tubing Co., Ltd., The, Derby Works, Vale Rd., London, N.4. T.: Stamford Hill 6696. Flexible metal bellows; tubing and fittings.

Randall, James H., and Son, Ltd., Paddington Green Works, London, W.2. T.: Ambassador 1661. Sheet metal work. Spinning.

Ransome and Marles Bearing Co., Ltd., Stanley Works, Newark-on-Trent. T.: Newark 456-9. Bearings for engines, etc.

Renold Chains, Ltd., Renold House, Wythenshawe, Manchester. T.: Mercury 5221. Aircraft precision chains.

Riley, Robert, Ltd., Milkstone Spring Works, Rochdale. T.: Rochdale 2237. Aircraft springs. Specialists in beryllium copper springs.

Robinson, L., and Co. (Gillingham), Ltd., 26 London Chambers, Gillingham, Kent. Jubilee clips.

Salisbury Precision Engineering, Ltd., Heston Airport, Hounslow, Middx. T.: Hayes 3844. Airframe sections, ground equipment, optical inspection projectors.

Salter, Geo., and Co., Ltd., High St., West Bromwich. T.: West Bromwich 1855. Springs, roller bearings, circlips, retaining rings, fasteners. Grey-iron castings.

Samlesbury Engineering, Ltd., Samlesbury Airfield, nr. Blackburn, Lancs. T.: Blackburn 44668. Major aircraft components; jigs, tools and fixtures; precision machinists.

Sheepbridge Alloy Castings, Ltd., Hamilton Rd., Sutton-in-Ashfield, Notts. T.: Sutton-in-Ashfield 590. Bi-metal brake drums.

Siegrist Orel, Ltd., 39 Berners St., London, W.1. T.: Museum 0032. Neoprene and latex sleeves and cable markers. Electrical instruments.

Simplifix Couplings, Ltd., Beacon Works, Hargrave Rd., Maidenhead, Berks. T.: Maidenhead 5100. Joints for copper tubes; cold-drawn steel and Dural tubes, etc.

Skefco Ball Bearing Co., Ltd., The, Luton, Beds. T.: Luton 5700. Ball bearings, cylindrical, taper and spherical roller bearings; pulleys and rollers.

Stewart Aeronautical Supply Co., Ltd., Adastral House, Lowfield Heath, Crawley, Sussex. T.: Horley 4300. Aeronautical equipment, spares.

St. Helens Cable and Rubber Co., Ltd., St. Helens Works, Slough, Bucks. T.: Slough 20333. Electric cable and general rubber goods.

Stream-Line Filters, Ltd., Ingate Pl., London, S.W.8. T.: Macaulay 1011-3. Filters for aviation fuels; water separators.

Superflexit, Ltd., 118 Buckingham Av., Slough, Bucks. T.: Slough 24561. Non-metallic flexible tubing and hoses.

Taylor, C. F., (Metal Workers), Ltd., Molly Millars Lane, Wokingham, Berks. T.: Wokingham 1005-6. Sheet-metal work; coppersmiths; stressed-skin structures. Design and manufacture of jigs, tools and fixtures. Glassfibre mouldings.

Tempered Spring Co., Ltd., The, Warren St., Sheffield, 4, Yorks. T.: Sheffield 21333. Springs.

Tenaplas (Sales), Ltd., 24-25 Manchester Sq., London, W.1. T.: Welbeck 7941. Co-axial cables, P.V.C. and polythene insulated wire, insulator sleevings, polythene waterpipe systems, chemical plant and corrosion-resistant ware; thermoplastic extrusions.

Terry, Herbert, and Sons, Ltd., Redditch, Worcs. T.: Redditch 61. Springs, presswork, wirework, hose clips, Anglepoise lamps, etc.

Torrington Co., Ltd., The, Torrington Av., Coventry. T.: Coventry 74241-6. Needle and roller bearings; bolts and screws.

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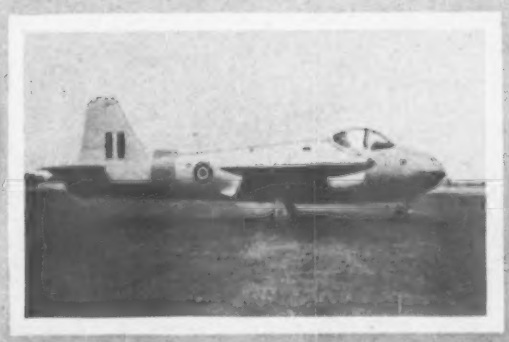

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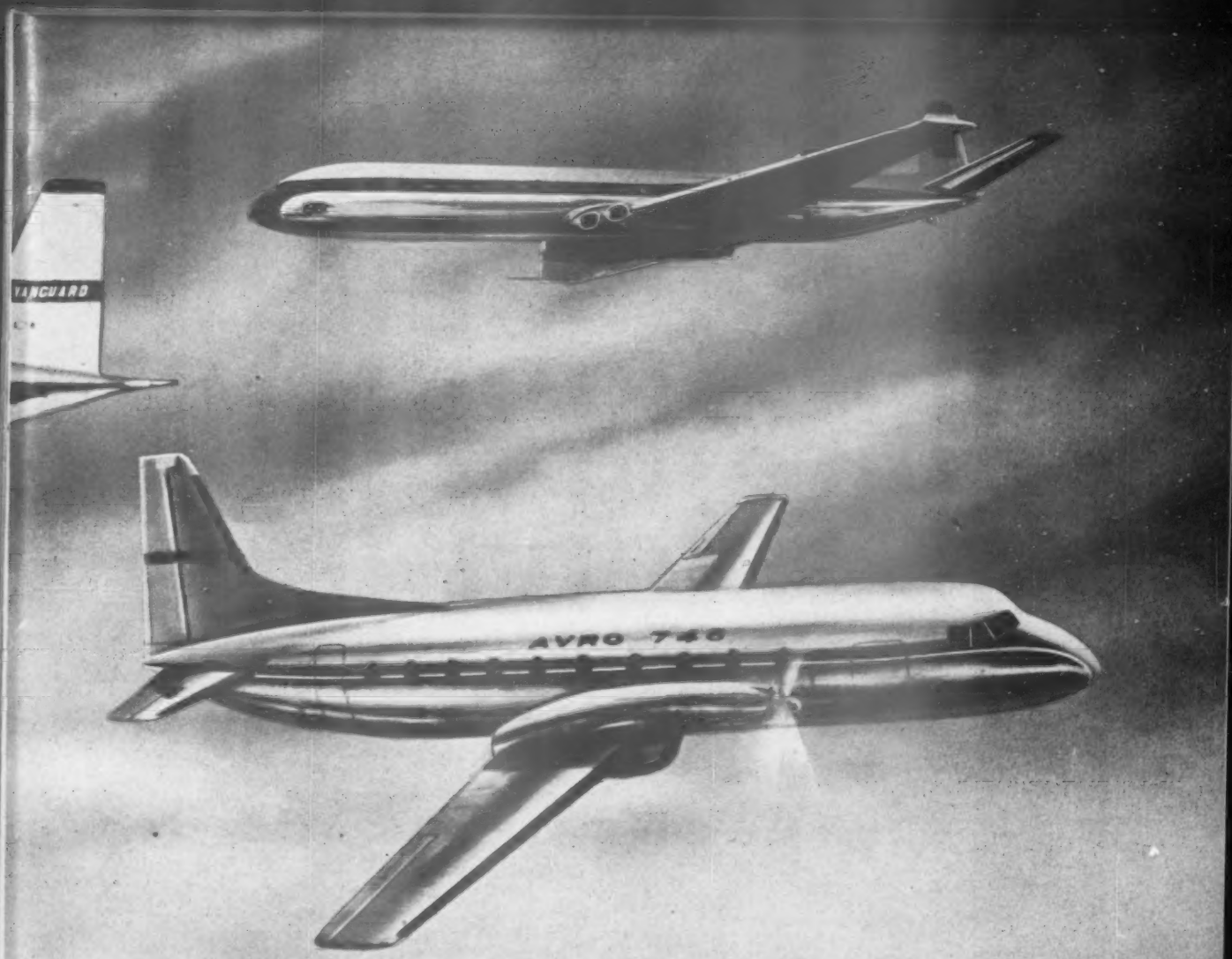

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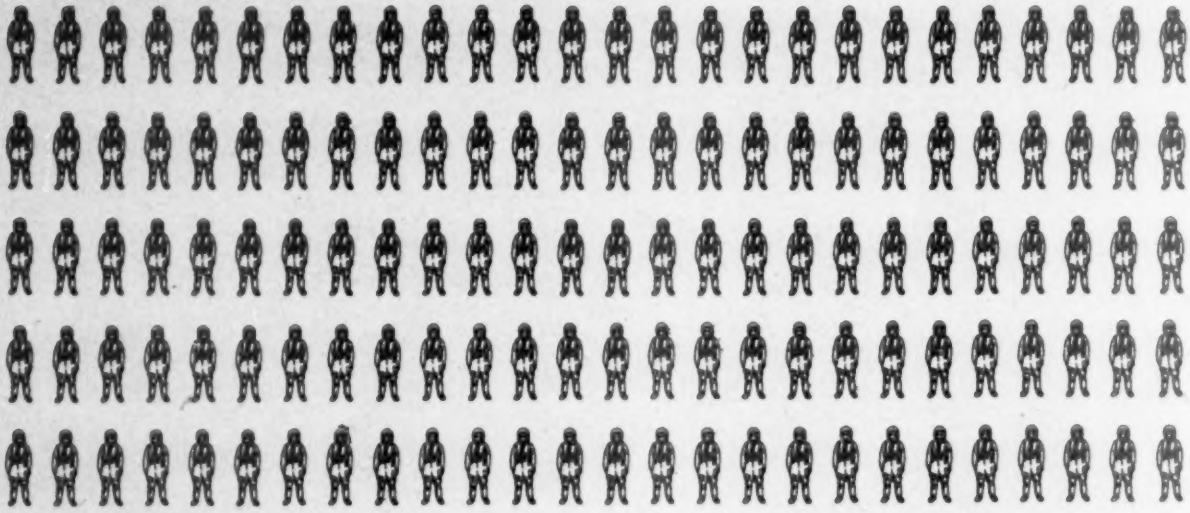

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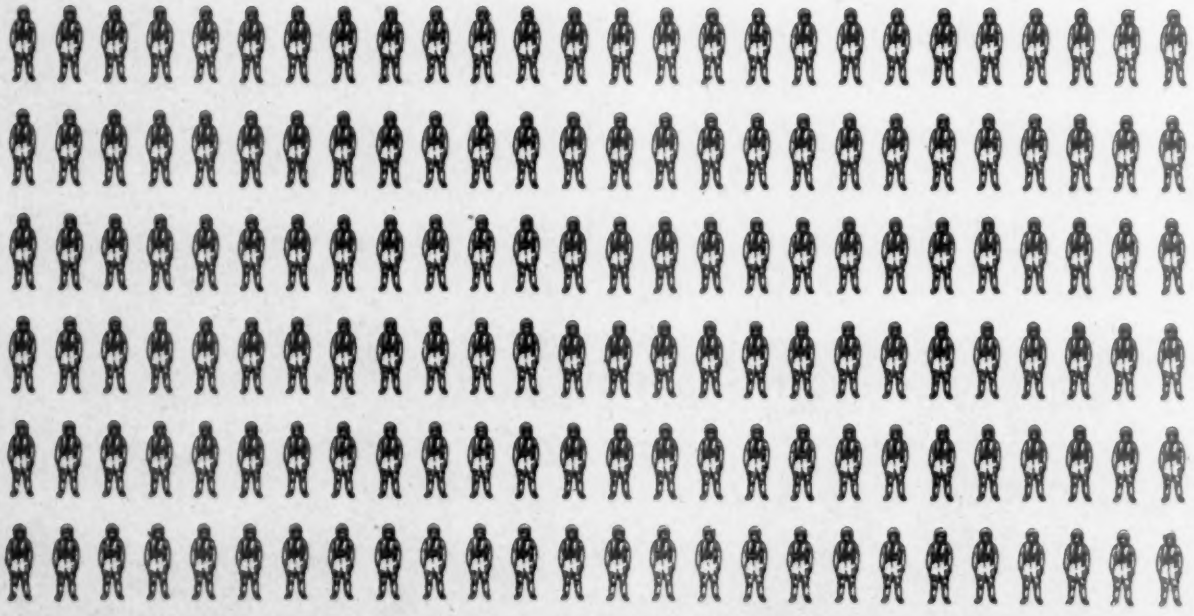

MARTIN-BAKER AIRCRAFT COMPANY LIMITED

Trade Directory . . . .

Tucker Eyelet Co., Geo., Ltd., Walsall Rd., Birmingham, 22. T.: Birchfields 4811. "Pop" and "Imex" rivets; eyelets and small metal pressings.

Turner and Savage, Ltd., 140 Willesden Lane, London, N.W.6. T.: Maida Vale 4881. Panel beaters and sheet-metal specialists.

United Steel Companies, Ltd., 17 Westbourne Rd., Sheffield, 10. T.: Sheffield 60081; and 8 Grosvenor Gardens, London, S.W.1. T.: Sloane 4533. Steel strip and wire.

Vandervell Products, Ltd., Western Av., London, W.3. T.: Acorn 2251. Thin-wall precision-finished crankshaft main and connecting-rod big-end bearings; thin-wall bushings and thrust washers.

Weathershields, Ltd., 48 Moor St., Birmingham. T.: Midland 2074. Hoodings and windows. Tube lock nuts.

Weston, Charles, and Co., Ltd., Irwell Bank Works, Douglas Green, Pendleton, Salford, 6. T.: Pendleton 2857-9. Oil seals and oil-sealing devices.

Weyburn Engineering Co., Ltd., Elstead, Godalming, Surrey. T.: Elstead 2141. Precision engineers. Camshafts, governors, pumps, etc.

Wilkinson Rubber Linatex, Ltd., Frimley Rd., Camberley, Surrey. T.: Camberley 1595. Flexatex hose; self-sealing tank coverings; Linatex seals.

Williamson, W. and A., and Co., Ltd., Hook Rise, Kingston By-pass, Surbiton, Surrey. T.: Elmbridge 6484. Fuel and oil tanks; sheet-metal work.

Y.S.C., Ltd., The, 45-47 Copeland Rd., London, S.E.15. T.: New Cross 6113. A.G.S. spares; bolts, screws, etc.

4 — Tools and Workshop Equipment

Abingdon King Dick, Ltd., Tyseley, Birmingham, 11. Hand tools for repair and maintenance.

Adcola Products, Ltd., Gauden Rd., London, S.W.4. T.: Macaulay 4272. Soldering instruments and equipment; solder jointing for radio and radar.

Aerocontacts (Ground Equipment), Ltd., Gatwick Airport, Horley, Surrey. T.: Horley 5511. Aircraft ground equipment and workshop equipment.

Aerograph Co., Ltd., 47 Holborn Viaduct, London, E.C.1. T.: City 4361. Spray-painting equipment.

Aerolex, Ltd., Camberley, Surrey. T.: Camberley 1500. Assemblies and tools.

Air Industrial Developments, Ltd., Aidspray Works, Shenstone, nr. Lichfield, Staffs. T.: Shenstone 341-5. Spray-painting and compressed-air equipment.

Aircraft Engineering and Jigs, Ltd., Wren Works, Chadderton, Lancs. T.: Chadderton 5691. Jigs and tools.

Allied Electronics, Ltd., 28 Upper Richmond Rd., Putney, London, S.W.15. T.: Vandyke 1856. Simmonds Pacitor fuel-gauge test console.

Amal, Ltd., Holdford Rd., Witton, Birmingham, 6. T.: Birchfields 4571. Jet-calibrating machines; Bunsen burners and injectors.

Archdale, James, and Co., Ltd., Ledsam St., Birmingham, 16. Milling and drilling machines, etc.

Asquith, Wm., Ltd., Halifax House, Strand, London, W.C.2. T.: Trafalgar 7224. Drilling and horizontal-boring machines.

Atkin, W. T., (Tottenham), Ltd., 178 St. Ann's Rd., Tottenham, London, N.15. T.: Stamford Hill 6686. Press toolmakers and metal stampers.

Autoset (Production), Ltd., Stour St., Birmingham, 18. T.: Edgbaston 1143-4. Castors, drawer slides, engineers' clamps, bearings, trucks, trolleys and transporters.

Aviation Traders, Ltd., 21 Wigmore St., London, W.1. T.: Museum 7791; Southend Airport, Essex. T.: Rochford 56491; and Stansted Airport, Essex. T.: Takeley 391. Engine stands and test-bed installations, jigs and fixtures.

Balfour, Arthur, and Co., Ltd., Capital Steel Works, Sheffield, 3. T.: Sheffield 22071. Engineers' small tools.

Bardolph, J. F., and Partners, Ltd., 1 Robert St., Adelphi, London, W.C.2. T.: Trafalgar 1927. Myers riveting clamps.

Benton and Stone, Ltd., Enots Works, Aston Brook St., Birmingham, 6. T.: Aston Cross 1905. Centralized lubricating systems; machine-tool coolant fittings, etc.

Birlec, Ltd., Birlec Works, Tyburn Rd., Birmingham, 24. T.: East 1544. Furnaces for heat treatment and melting; absorption dryers.

Black and Decker, Ltd., Harmondsworth, Middx. T.: Skyport 2411-9. Portable electric tools; heavy-duty Holguns; screwdrivers; sanders, polishers and drills.

Broom and Wade, Ltd., High Wycombe, Bucks. T.: High Wycombe 1630. Air compressors and pneumatic tools.

Brown, David, and Sons (Huddersfield), Ltd., Park Works, Huddersfield, Yorks. T.: Huddersfield 3500. Gear-cutting plant and equipment; gears and gear units.

Brown, David, Industries, Ltd., (Machine Tool Division), Britannia Works, Sherborne St., Manchester, 3. Gear hobbing and shaving machines.

Brown, David, Industries, Ltd., Tool Division, Park Works, Huddersfield, Yorks. Gear-cutting tools, jigs, fixtures, etc.

B.S.A. Tools, Ltd. (Sole Agents, Burton, Griffiths and Co., Ltd.), Kitts Green, Birmingham, 13. T.: Stechford 3071 (machine tools); Victoria 2351 (small tools). Tools.

Burnley Aircraft Products, Ltd., Fulledge Works, Burnley, Lancs. T.: Burnley 3121-2 and 3203. Jigs and tools; components.

Burton, Griffiths and Co., Ltd., Machine Tools Division, Kitts Green, Birmingham, 33. T.: Stechford 3071; and Small Tools Division, Montgomery St., Birmingham, 11. T.: Victoria 2351. Machine and small tools.

Carter, B. and F., and Co., Ltd., Albion Works, Bolton. T.: Bolton 4344. Counting instruments.

Chamberlain Industries, Ltd., Staffa Works, Staffa Rd., Leyton, London, E.10. T.: Leytonstone 3678. Tube-bending machines, presses, overhead travelling and mobile cranes.

Churchill, Charles, and Co., Ltd., Coventry Rd., South Yardley, Birmingham. T.: Acocks Green 2281. Machine tools.

Churchill Machine Tool Co., Ltd., The, Broadheath, Manchester. T.: Altrincham 3262. Machine tools.

Constructors, Ltd., Tyburn Rd., Birmingham, 24. Steel storage equipment.

Cornercroft, Ltd., Ace Works, Queen Victoria Rd., Coventry. T.: Coventry 40561. Jigs, press tools, special-process machines, gauges, assembly fixtures.

Dancer and Hearne Bros., Ltd., Penn St., nr. Amersham, Bucks. Jigs and tools; rubber press tools; Hufford tools; templates.

Darwins, Ltd., Tinsley, Sheffield, 9. T.: Sheffield 41341. Hacksaw blades; permanent magnets, tool bits.

Dowding and Doll, Ltd., 364 Kensington High St., London, W.14. T.: Western 8077. Machine tools, injection-moulding and die-casting machines; thread-milling hobs.

Dunlop and Ranken, Ltd., 147 The Headrow, Leeds, 1. T.: Leeds 27301. Engineers' and contractors' hand-forged tools.

Edwards, F. J., Ltd., 359-361 Euston Rd., London, N.W.1. T.: Euston 4681. Machine tools and presses.

Equipment and Engineering Co., Ltd., The, 2-3 Norfolk St., Strand, London, W.C.2. T.: Temple Bar 1088; and 164-170 Mare St., London, E.8. T.: Amherst 6301. Electromagnetic crack detectors; Magnaflux crack-detecting ink. Degreasing plant.

Ferro Enamels, Ltd., Wombourne, Wolverhampton. T.: Wombourne 2281. Furnaces for high-temperature ceramic coatings on nickel-chrome alloys and sheet iron.

Fielding and Platt, Ltd., Atlas Works, Gloucester. T.: Gloucester 20351. Presses, machines and ancillary equipment.

Firth Brown Tools, Ltd., Sheedicut Works, Carlisle St., E. Sheffield, 4. T.: Sheffield 27151. Engineers' cutting tools.

Henderson Safety Tank Co., Ltd., The, Elstree Way, Borehamwood, Herts. T.: Elstree 1758-9 and 1917. Jigs and tools.

Herbert, Alfred, Ltd., P.O. Box No. 30, Edgwick Works, Coventry. T.: Coventry 88781. Machine tools; small tools; grinding wheels; measuring and inspection equipment.

Holbrook Machine Tool Co., Ltd., 44 Martin St., Stratford, London, E.15. T.: Maryland 2451. Precision lathes.

Hopkins, E. C., Ingleby Works, Grosvenor St. West, Birmingham, 16. Flexible shaft machines.

Jenks Bros., Ltd., Britool Works, Bushbury, Wolverhampton. T.: Wolverhampton 31281. Britool socket and ring wrenches.

King, Geo. W., Ltd., Argyle Works, Stevenage, Herts. T.: Stevenage 440. Gantry cranes, conveyors, hoisting equipment and sliding-door gear, etc.

Lacy-Hulbert and Co., Ltd., Boreas Works, Beddington, Croydon. T.: Croydon 5504. Compressors, vacuum pumps, exhausters, desiccators, spray-painting equipment and pneumatic appliances.

Leytonstone Jig and Tool Co., Ltd., Leytool Works, High Rd., Leyton, London, E.10. T.: Leytonstone 5022. Jigs, fixtures and press tools and equipment.

Loewy Engineering Co., Ltd., The, Wallisdown Rd., Bournemouth, Hants. T.: Winton 5000; and 1 Albemarle St., London, W.1. T.: Hyde Park 9959. Martin Marform metal-forming equipment.

Marbaix, Gaston E., Ltd., Devonshire House, Vicarage Cres., Battersea, London, S.W.11. T.: Battersea 8888. Machine tools.

Marley, W. H., and Co., Ltd., New Southgate Works, 105 High Rd., London, N.11. T.: Enterprise 5234 and 5578. Machine-tool accessories.

Martonair, Ltd., Parkshot, Richmond, Surrey. Pneumatic equipment; air hoists.

Masson Seeley and Co., Ltd., 137-139 Euston Rd., London, N.W.1. T.: Euston 9021-7. Masseeley nameplate machines; stamping and marking machines and presses. Aircraft and engine components.

Mercury Truck and Tractor Co., Ltd., The Quay, Gloucester. T.: Gloucester 24451-2. Hydraulic test equipment and tripod jacks; power-plant stands.

Morgan Crucible Co., Ltd., The, Battersea Church Rd., Battersea, London, S.W.11. T.: Battersea 8822. Crucibles and crucible furnaces.

Morris, B. O., Ltd., Morrisflex Works, Britton Rd., Stoke, Coventry. T.: Coventry 5081. Morrisflex flexible shaft equipment, polishing lathes, backstand idlers and polishing materials; rotary wire and fibre brushes; special-purpose machines.

Neill, James, and Co. (Sheffield), Ltd., Napier St., Sheffield, 11. T.: Sheffield 26781. Steel Eclipse hacksaw blades and frames; engineers' tools, permanent magnets and chucks.

Northey Rotary Compressors, Ltd., 200-202 Alder Rd., Parkstone, Poole, Dorset. T.: Parkstone 4900. Oil-free blowers for electro-plating, metal polishing and spray-painting plants.

Power Flexible Tubing Co., Ltd., The, Derby Works, Finsbury Park, London, N.4. T.: Stamford Hill 6696. Metalflex hose for steam presses; steel ventilating hose; flexible shaft outer casings; cable armouring; bellows-type expansion joints.

Power Jacks, Ltd., Valetta Rd., Acton, London, W.3. T.: Shepherd's Bush 3443. Hydraulic jacks and Newton Hydratruck hydraulic lift trucks.

Randall, James H., and Son, Ltd., Paddington Green Works, London, W.2. T.: Ambassador 1661. Workshop equipment.

Randalrak, Ltd., 106 Victoria St., London, S.W.1. T.: Victoria 3485. Randalrak industrial storage and handling equipment; Planstore storage and filing equipment.

Ransomes Sims and Jeffe ies, Ltd., Orwell Works, Ipswich. T.: Ipswich 2201. Electric, fork-lift and tiering trucks.

Robertson, W. H. A., and Co., Ltd., Lynton Works, Bedford. Trimming and slitting equipment, etc.

Rossell, Henry, and Co., Ltd., Waverley Works, Effingham Rd., Sheffield. Jigs, fixtures and engineers' small tools.

Salter, Geo., and Co., Ltd., West Bromwich. T.: West Bromwich 1855. Weighing machines and spring balances.

School Division—F. W. Berk and Co., Ltd., Brent Cres., North Circular Rd., N.W.10. T.: Elgar 3533. Shot-blasting metal and plastic spraying and supply of associated equipment.

Schrader's Son, A., Division of Scovill Manufacturing Co., 829 Tyburn Rd., Erdington, Birmingham, 24. Tyre valves, parts and pressure gauges.

Scintilla, Ltd., 20 Carlisle Rd., The Hyde, Hendon, London, N.W.9. T.: Colindale 8844. Lesto portable tools, etc.

Scottish Distributors, Ltd., Aeronautical and Scientific Division, 62 Shirland Rd., Maida Vale, London, W.9. T.: Cunninghame 8080. Laboratory equipment; fuel-measuring equipment; engineers' hand and machine tools. Engineers Tools Division: High-speed cutters, etc.

Skinners (Southampton), Ltd., Millbrook Trading Estate, Southampton. T.: Southampton 71167-8. Press tools, jigs and fixtures, gauges; prototype machining.

Steels Engineering Products, Ltd., Crown Works, Sunderland. T.: Sunderland 56281. Coles mobile cranes.

Talbot Tool Co., Ltd., 87 Borough High St., London, S.E.1. T.: Hop 3722 and 3310. Grip drill and reamer jig bushes; Nurogrip and Polygrip jig bushes, etc.

Taylor, Taylor and Hobson, Ltd. (A Division of Rank Precision Industries, Ltd.), Leicester. Profile projectors, electrical comparators; alignment telescopes, etc.

Turner Brothers (Birmingham), Ltd., Galvanic Works, Cleveland St., Birmingham, 19. T.: Aston Cross 1741. Press tools, jigs, fixtures and power presses.

Vactric (Precision Tools), Ltd., 196 Sloane St., London, S.W.1. T.: Sloane 9656. Precision tools, gauges, moulds, etc.

Vaughan, Edgar, and Co., Ltd., Legge St., Birmingham, 4. Oils, compounds and salts.

Ward, H. W., and Co., Ltd., Dale Rd., Birmingham, 29. Capstan and turret lathes.

Wickman, Ltd., Banner Lane, Tile Hill, Coventry. T.: Coventry 65231. Automatic lathes, tool-grinding machines; Wimet tools; dies, press tools, etc.

Williams and James (Engineers), Ltd., Chequers Bridge, Gloucester. T.: Gloucester 24021-3. Air compressors.

Wolf Electric Tools, Ltd., Pioneer Works, Hanger Lane, Ealing, W.5. T.: Perivale 5631. Portable electric tools.

Young, A. S., and Co., Ltd., Tower Works, Woodside Lane, N. Finchley, London, N.12. T.: Hillside 6606-7. Oxy-acetylene welding and cutting equipment, rods and accessories.

Trade Directory . . . .

5——Controls, Systems and Accessories

A.B.C. Motors, Ltd., Walton-on-Thames, Surrey. T.: Walton-on-Thames 774-5. Auxiliary power units; refuelling units for seaplanes, etc.

Amal, Ltd., Holdford Rd., Witton, Birmingham, 6. T.: Birchfield 4571. Ball and roller joints, flexible distance controls, float chambers, jet calibrating machines, flowmeters, injectors and carburetters.

Coventry Victor Motor Co., Ltd., Coventry. T.: Coventry 5054-6. Auxiliary powerplant prime movers. Flying Neptune light aero-engine.

Duval, S., and Sons, Ltd., 8-12 Wadsworth Rd., Greenford, Middx. T.: Perivale 7807-8. Precision engineering, specialists in cyclic and other time-switch devices.

Evershed and Vignoles, Ltd., Acton Lane Works, Chiswick, London, W.4. T.: Chiswick 3670. F.H.P. motors, servo amplifiers and flap positioners.

Godden, M. H. (Cheltenham), Ltd., Bouncers Lane, Cheltenham, Glos. T.: Cheltenham 7202-3. De-icing equipment.

Hale, Hamilton and Co., Ltd., Frays Mill Works, Cowley Rd., Uxbridge, Middx. T.: Uxbridge 6525-6. Pressure reducing and solenoid valves; pressure control equipment.

Harvey Electronics, Ltd., 273 Farnborough Rd., Farnborough, Hants. T.: Farnborough 1120. Servo units, bulk erasers for magnetic tape; specialized electronic and electro-mechanical devices.

Keelavite Rotary Pumps and Motors, Ltd., Allesley, Coventry. T.: Meriden 441. Keelavite hydraulic pumps, motors, cylinders and control gear.

R.M.B. Engineering, Brook St., Tring, Herts. T.: Tring 3338. Pipeline unions and cups.

Scottish Distributors, Ltd., Aeronautical and Scientific Division, 62 Shirland Rd., Maida Vale, London, W.9. T.: Cunningham 8080. Electric motors; air-pressure and vacuum pumps, etc.

Seton Creaghe Engineering Co. (1950), Ltd., Trading Estate, Park Royal Rd., London, N.W.10. T.: Elgar 5257-8. High-precision electro-mechanical devices and mechanisms.

Stemco, Ltd., 740 High Rd., Tottenham, London, N.17. T.: Tottenham 5371. Brodie-Kent meters, strainers, eliminators, flow-control valves, refuellers, etc.

Thermotank, Ltd., 150 Helen St., Glasgow, S.W.1. Air-conditioning plant.

T.K.S. (Aircraft De-icing), Ltd., Drayton House, Gordon St., London, W.C.1. T.: Euston 4650. De-icing systems and fluids.

Varley Pumps and Engineering, Ltd., Ferry Lane, Brentford, Middx. T.: Ealing 1186. Pumping equipment; nitrogen reducing valves.

White, S. S., Dental Manufacturing Co. (G.B.), Ltd., The (Industrial Division), Britannia Works, St. Pancras Way, London, N.W.1. T.: Euston 5393. Torsional flexible remote controls and flexible shaft assemblies for engine speed indicators.

6——Instrument Equipment

Accurate Recording Instrument Co., Aric Works, Windsor Avenue, Merton, London, S.W.19. T.: Liberty 5661. Mechanical dial-type instruments and controls.

A.J.W. (Instruments), Ltd., Gatwick Airport, Horley, Surrey. T.: Horley 1510 (ext. 38 and 105) and 1420. Aircraft instruments.

Ancillary Developments, Ltd., Ancils Works, Surrey Avenue, Camberley, Surrey. T.: Camberley 3443. Aircraft instruments and components, etc.

Appleby and Ireland, Ltd., Kempshott House, nr. Basingstoke. T.: Dummer 216. Vacuum and pressure instruments; diaphragms, capsules and bellows.

Avimo, Ltd., Taunton, Somerset. T.: Taunton 3634-5. A.S.I. pressure heads, pipe couplings for coolant, oil and fuel pipe lines; film assessors and analysers; electronic apparatus.

Barnet Instruments, Ltd., Bath Place, Barnet, Herts. T.: Barnet 0066. Pressure, vacuum and compound gauges, and testing equipment.

British Rototherm Co., Ltd., The, Merton Abbey, London, S.W.19. T.: Liberty 7661. Rototherm dial-type bi-metallic and distance-reading temperature gauges, temperature and pressure recorders.

Browne, Henry, and Son, Ltd., Station Works, Barking, Essex. T.: Ripple way 4054-6. Sestrel aero compasses and other instruments.

Carter, B. and F., and Co., Ltd., Bolton, 17, Lancs. Ratchet and revolution counters; speed indicators, measuring units, etc.

Cooke, Troughton and Simms, Ltd., Haxby Rd., York. T.: York 24112. Microscopes.

Counting Instruments, Ltd., 5 Elstree Way, Boreham Wood, Herts. T.: Elstree 1382. Mechanical and electro-magnetic counters, etc.

Dent and Co., and Johnson, Ltd., Linwood, Renfrewshire. T.: Johnstone 109. Dent-Johnson compasses, etc.

Dowty Nucleonics, Ltd., Cheltenham, Glos. T.: Cheltenham 53606. Vibration instruments, revolution indicators, strain and temperature measurement, high-speed counting equipment.

Greenwood, P. W. (Willesden), Ltd., 62 Shirland Rd., London, W.9. T.: Cunningham 4422. Blind-flying and navigational instruments.

K.D.G. Instruments, Ltd., Purley Way, Croydon, Surrey. T.: Thornton Heath 3868. Aircraft instruments.

Kent, George, Ltd., Biscot Rd., Luton, Beds. T.: Luton 2440. Flow meters, etc.

Measuring Instruments (Pullin), Ltd., Electrin Works, Winchester St., Acton, London, W.3. T.: Acorn 4651. Electrical indicating instruments, relays, test and control gear.

Munro, R. W., Ltd., Cline Rd., Bounds Green, London, N.11. T.: Enterprise 4422. Flight-record instruments, indicators and gauges.

Page Engineering Co., Page Works, Forge Lane, Sunbury-on-Thames, Middx. T.: Sunbury-on-Thames 2642. Electrical and mechanical instruments and equipment.

Painton and Co., Ltd., Kingsthorpe, Northampton. T.: Northampton 34751. Electrical components.

Power Flexible Tubing Co., Ltd., The, Derby Works, Vale Rd., Finsbury Park, London, N.4. T.: Stamford Hill 6696. Flexible metallic bellows; temperature-control apparatus, fuel pumps.

Reid and Sigrist, Ltd., Braunstone Works, Braunstone, Leicester. T.: Leicester 88101-4. Aeronautical instruments; specialists in gyroscopic instruments and test gear.

Rotameter Manufacturing Co., Ltd., 602 Purley Way, Croydon, Surrey. T.: Croydon 3816-9. Flow meters.

Royston Instruments, Ltd., Canada Rd., Oyster Lane, Byfleet, Surrey. T.: Byfleet 4358. Data recording, handling and processing equipment. Midas magnetic tape-recorders.

Scottish Distributors, Ltd., Aeronautical and Scientific Division, 62 Shirland Rd., Maida Vale, London, W.9. T.: Cunningham 8080. Gyro and meteorological instruments, solenoids, simulator equipment.

Sanley, W. F., and Co., Ltd., Avery Hill Rd., New Eltham, London, S.E.9. T.: Eltham 3836. Instruments.

Test Equipment, Ltd., Gatwick Rd., Crawley, Sussex. T.: Crawley 2350. Gyroscopic instruments and research equipment.

Langham Thompson, J., Ltd., 88 High Rd., Bushey Heath, Herts. T.: Bushey Heath 2411. Pressure transducers, accelerometers, etc.

Williams and James (Engineers), Ltd., Chequers Bridge, Gloucester. T.: Gloucester 24021. Reducing valves and pressure regulators; W. and J. "pneumerstat."

Wynstruments, Ltd., Staverton Aerodrome, Gloucester. T.: Churchdown 3264. Control and instrumentation engineers.

7——Radio and Electrical Equipment

Aerocontacts, Ltd., Gatwick Airport, Horley, Surrey. T.: Horley 5511. Electrical and radio equipment.

Aeronautical Radio Services, Ltd., Doman Rd., Camberley, Surrey. T.: Camberley 2341. Aircraft radio and radar.

Air Transport (Charter) (C.I.), Ltd., 7 Willow Rd., Poyle Trading Estate, Colnbrook, Bucks. T.: Colnbrook 2654-6. Electronic workshop and field test equipment.

Anticoustic Co., The, 204 High St., Guildford, Surrey. T.: Guildford 66488. Electrical and electronic equipment; ear defenders and sound insulators; acoustic booths and soundproof cabinets.

Automatic Coil Winder and Electrical Equipment Co., Ltd., 92-96 Vauxhall Bridge Rd., London, S.W.1. T.: Victoria 3404. Electrical and electronic test equipment; coil-winding machines.

Bonella, D. H., and Son, Ltd., West Hill, Hoddesdon, Herts. T.: Hoddesdon 2283. Electrical accessories.

British Communications Corpn., Ltd., Exhibition Grounds, Wembley, Middx. T.: Wembley 1212. VHF communications equipment; multi-channel automatic recording system for ATC, flight-deck communications system for aircraft carriers, electronic measuring apparatus.

British Electrical Resistance Co., Ltd., Queensway, Enfield, Middx. T.: Howard 2411. Auto-transformers, resistances, rheostats, potentiometers, etc.

Butlers, Ltd., Atlantic Works, Grange Rd., Small Heath, Birmingham, 10. T.: Victoria 3491-6. Lamps; marker lights.

Cathodeon, Ltd., Church St., Cambridge. T.: Cambridge 56481. Fire-protection and high-voltage high-speed evacuated relay switches.

Crypton Equipment, Ltd., Bridgwater, Somerset. Electrical equipment.

C.W.C. Equipment, Ltd., Acorn Works, Kings Grove, Maidenhead, Berks. T.: Maidenhead 22.5. Electrical switches.

Davis and Timmins (Aircraft), Ltd., 270 High Rd., Ilford, Essex. T.: Ilford 3460. Electrical parts and cabin lamps.

"Diamond H" Switches, Ltd., Gunnersbury Av., London, W.4. T.: Chiswick 6414. Miniature hermetically sealed aircraft-type relays, rotary and toggle switches and thermostats.

Edison Swan Electric Co., Ltd., 155 Charing Cross Rd., London, W.C.2. T.: Gerrard 8660. Fluorescent and flood-lighting equipment; cables. Ediswan Mazda valves and cathode-ray tubes; electronic equipment, etc.

Electrical and Refrigeration Services, Ltd. (E.R.S (London), Ltd.), Brookwood Rd., London, S.W.18. Radio connectors, etc.

Electronic Components, Weedon Rd., Industrial Estate, Northampton. T.: Northampton 2467. Faders, attenuators, switches, etc.

Evershed and Vignoles, Ltd., Acton Lane Works, Chiswick, London, W.4. T.: Chiswick 3670. Electrical controls and test sets.

Fairey Marine, Ltd., Hamble, nr. Southampton, Hants. T.: Hamble 2135. Radomes.

Greenwood, P. W. (Willesden), Ltd., 62 Shirland Rd., London, W.9. T.: Cunningham 4422. Electrical components and accessories.

Harvey Electronics, Ltd., 273 Farnborough Rd., Farnborough, Hants. T.: Farnborough 1120. Servo-mechanisms, power-supply units, etc.

International Aeradio, Ltd., 40 Park St., London, W.1. T.: Hyde Park 5024. Telecommunications, radio and radar aids.

Land, Air and Sea Instruments Co., Ltd., 328 Grand Buildings, Trafalgar Sq., London, W.C.2. T.: Whitehall 4864. Lascom aircraft radio communication and navigation equipment; VHF radio telephones.

Lyon, Arthur, and Co. (Engineers), Ltd., 6 Carlos Place, Grosvenor Sq., London, W.1. T.: Hyde Park 9141. Generator test benches and inverter testers.

Magnetic Devices, Ltd., Exning Rd., Newmarket. T.: Newmarket 3181. Relays, production of items manufactured by Power Controls, Ltd.

M.B. Metals, Ltd., Vale Works, Vale Rd., Portslade, Sussex. T.: Hove 48623. Plugs and sockets; switches; lamps, suppressors; connectors.

Nife Batteries, Redditch, Worcs. T.: Redditch 157. Nife nickel cadmium alkaline accumulators for ground starter batteries, etc.

N.S.F., Ltd., 9 Stratford Place, London, W.1. T.: Langham 9561. N.S.F.-Oak and Cutler hammer switches, etc.

Page Engineering Co., Page Works, Forge Lane, Green St., Sunbury-on-Thames, Middx. T.: Sunbury-on-Thames 2642 and 2304. Switches; moving-coil relays; temperature indicators, etc.

Painton and Co., Ltd., Kingsthorpe, Northampton. T.: Northampton 34251. Attenuators and faders, stud switches, wire-wound potentiometers, midget RF chokes, etc.

Pye Telecommunications, Ltd., Newmarket Rd., Cambridge. T.: Teversham 3131. Pye ILS Ranger and Reporter mobile radio-telephones; Pye Transhailer electronic megaphone; 60-W. HF fixed-station and 1-kW. VHF transmitter.

Racal, Ltd., Western Rd., Bracknell, Berks. T.: Bracknell 941. Electronic equipment.

Rist's Wires and Cables, Ltd., Lower Milehouse Lane, Newcastle, Staffs. T.: Newcastle 69212-4. Cable and cable assemblies and looms, etc.

Santon, Ltd., Somerton Works, Newport, Mon. T.: Newport 71211. Rotary switches, etc.

Scottish Distributors, Ltd., Aeronautical and Scientific Division, 62 Shirland Rd., Maida Vale, London, W.9. T.: Cunningham 8080. General electrical equipment; plugs, switches, etc.

Siemens Edison Swan, Ltd., 155 Charing Cross Rd., London, W.C.2. T.: Gerrard 8660. Electrical cables; lighting equipment.

Simon Equipment, Ltd., 48-50 George St., Portman Sq., London, W.1. T.: Welbeck 2371. Magnetic monitoring equipment, timing indicator units, etc.

Technograph Printed Circuits, Ltd., 32 Shaftesbury Avenue, London, W.1. T.: Gerrard 4532. Printed circuits.

(Continued on page 148A)

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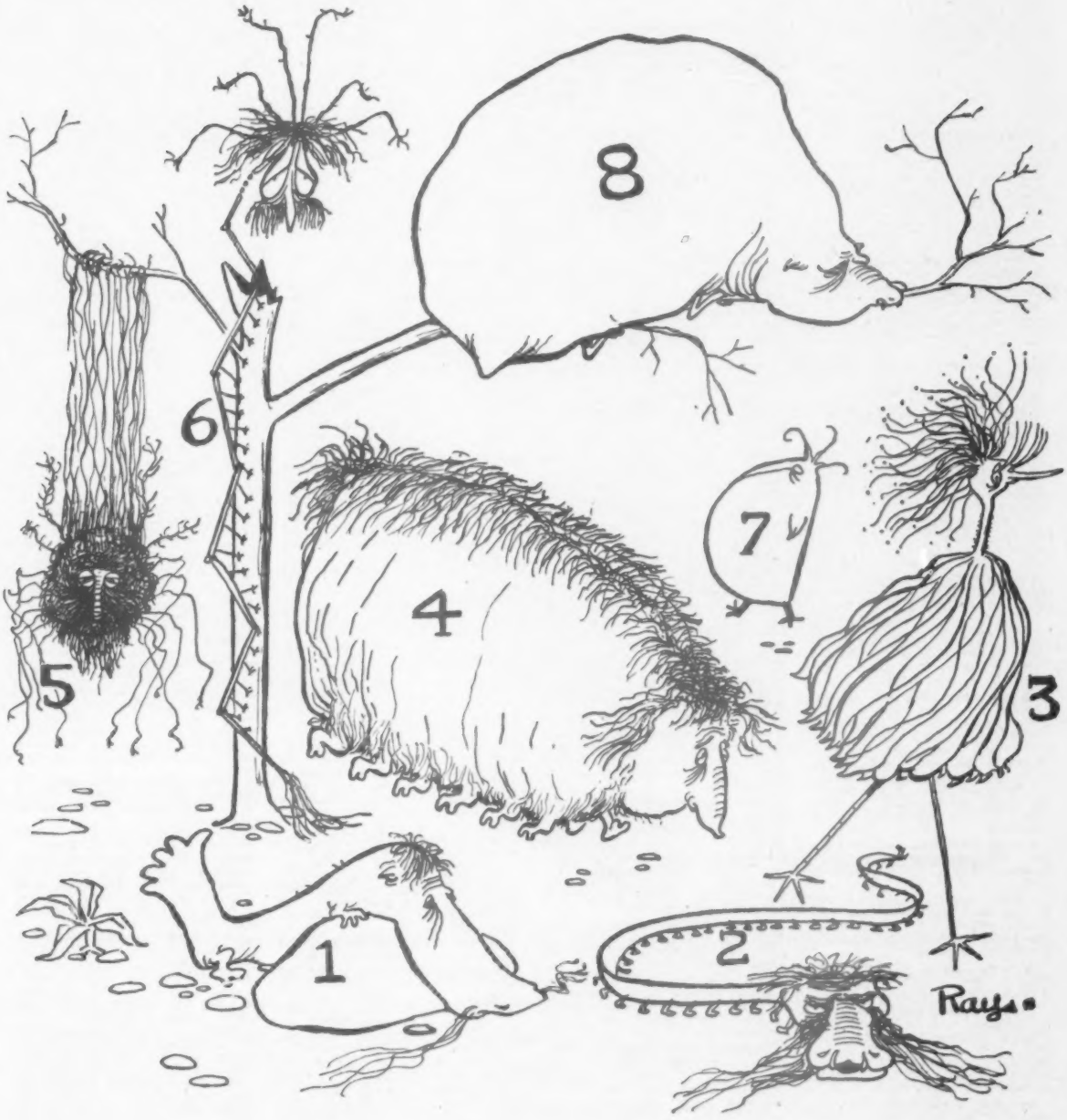

Key: 1, Lazy Leg. 2, Cross Strap. 3, Skirt.
4, Stowage Loop. 5, Lift Web. 6, Zig-Zag Stitch.
7, D Ring. 8, Mean Drift.

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8——*Survival Equipment and Flying Clothing*

Airborne Service Equipment, Ltd., Arterial Rd., Southend-on-Sea, Essex. T.: Eastwood 55265. Parachutes; air/sea rescue packs. R.A.F. web equipment, kitbags, haversacks.

Beaufort (Air-Sea) Equipment, Ltd., Victoria Rubber Works, Newton Heath, Manchester, 10. T.: Failsworth 1166. Air/sea rescue equipment, marine and flying equipment.

Black and Decker, Ltd., Harmondsworth, Middx. T.: West Drayton 2681-9. Air-rescue saws.

British Parachute Co., Ltd., Chapeltown St., Manchester, 1. T.: Ardwick 2414. Parachutes; general aircraft safety equipment.

Fairey Marine, Ltd., Hamble, nr. Southampton, Hants. T.: Hamble 2135. Folding dinghies.

Lea Bridge Industries, Ltd. (Aircraft Section), Priory Works, Arterial Rd., Southend-on-Sea. T.: Eastwood 55265. Air/sea rescue equipment, parachutes, Lindholme gear, etc.

Lewis, D., Ltd. (Dept. F.), 124 Gt. Portland St., London, W.1. T.: Museum 4314. Flying suits, goggles and gloves. Oxygen equipment.

Permutit Co., Ltd., The, Permutit House, Gunnersbury Av., London, W.4. T.: Chiswick 6431. Drinking-water filters; de-salting kits.

Rumbold, L. A., and Co., Ltd., Kingsgate Place, Kilburn, London, N.W.6. T.: Maida Vale 7366-7-8. Lifebelts, stretchers and folding invalid-carrying chairs.

Vosper, Ltd., P.O. Box No. 18, Portsmouth, Hants. T.: Cosham 79481. Seaplane and crash rescue tenders; fireboats.

Windak, Ltd., Woodside, Poynton, Cheshire. T.: Poynton 2261. Electrically heated airborne equipment and clothing.

9——*Miscellaneous Equipment and Services*

A.B.C. Motors, Ltd., Walton-on-Thames, Surrey. T.: Walton-on-Thames 774-5. Auxiliary power units; pumping and generating sets; bilging and refuelling units for seaplanes.

Abbey Panel and Sheet Metal Co., Ltd., Old Church Rd., Coventry. T.: Coventry 89461. Prototype and experimental work.

Aerogalley (Proprietors: Aerocontacts (Aircraft Distributors), Ltd.), Gatwick Airport, Surrey. T.: Horley 5511 and Livingstone 8811, ext. 6601. Aircraft catering equipment; British Commonwealth agents for Stiebel Eltron electrical galley equipment. Electrical galley equipment and "Sell" galley structures.

Aerolex, Ltd., Bridge Rd., Camberley, Surrey. T.: Camberley 1500. Quick-release lashing equipment; stretcher equipment; safety belts, anchorages.

Airborne Service Equipment, Ltd., Arterial Rd., Southend-on-Sea, Essex. T.: Eastwood 55265. R.A.F. banner and drogue targets (radar and non-radar); aircraft furnishings; kapok cushions.

Aircraft Furnishing, Ltd., 41 Lonsdale Rd., London, W.11. T.: Bayswater 6262-5. Aircraft passenger seats.

Airpak, Ltd., 76 Grosvenor St., London, W.1. T.: Mayfair 3467; and Overton, Hants. T.: Overton 259. Upholstery and insulation materials; Tropal and Tropaline.

Airwork, Ltd., 35 Piccadilly, London, W.1. T.: Regent 8494. Aircraft servicing, maintenance, etc.

Aviation Traders, Ltd., 21 Wigmore St., London, W.1. T.: Museum 7791; Southend Airport, Essex. T.: Rochford 56491; and Stansted Airport, Essex. T.: Takeley 391. Experimental design and production; airframe and engine repair.

Bury Felt Manufacturing Co., Ltd., Hudcar Mills, Bury, Lancs. Upholstery, carpeting, felts, strips, gaskets, washers and plastic foam.

Camerer Cuss and Co., 54-56 New Oxford St., London, W.1. T.: Museum 8968-9 and 4861. Aircraft clocks.

Cox, John F., and Co., Wyles St., Gillingham, Kent. Aircraft cloths.

Cullum Detuners, Ltd., 58 Highgate West Hill, London, N.6. T.: Fitzroy 1221. Detuners for jet test-bed silencing, mufflers, intake splitter systems.

Elsan Manufacturing Co., 51 Clapham Rd., London, S.W.9. Toilet units.

Fairey Marine, Ltd., Hamble, nr. Southampton, Hants. T.: Hamble 2135. Target conversions.

Fisons Pest Control, Ltd., Bourn, Cambs. Pest control.

Flight Equipment and Engineering, Ltd., 163-169 Brompton Rd., London, S.W.3. T.: Kensington 3698. Passenger seats.

Harper, C. E., Aircraft Co., Ltd., Exeter Airport, Clyst Honiton Devon. T.: Exeter 67451. Aircraft service and maintenance.

Ilford, Ltd., Ilford, Essex. T.: Ilford 3000. Photographic sensitized materials, equipment and chemicals.

International Aeradio, Ltd., 40 Park St., London, W.1. T.: Hyde Park 5024. Maps and map mountings. Aerad flight guides; route manuals, air-mileage handbooks and handbooks for pilots and navigators.

Kodak, Ltd., Kodak House, Kingsway, London, W.C.2. T.: Holborn 7841. Photographic equipment.

London Nameplate Manufacturing Co., Ltd., Tae, Zylo Works, Brighton, Sussex. T.: Brighton 27025. Nameplate manufacturers. Navigational instruments.

Mallock-Armstrong Co., The, Sussex House, 204 High St., Guildford, Surrey. T.: Guildford 66488. Ear defenders.

Mason, E. N., and Sons, Ltd., Architect Works, Colchester, Essex. T.: Colchester 5191. Photographic photo-copying and drawing-office equipment and materials.

Mavitta Drafting Machines, Ltd., Highlands Rd., Shirley, nr. Birmingham. T.: Solihull 2231. Drawing-office equipment.

M.B. Packaging, Ltd., North Rd., Lancing, Sussex. T.: Lancing 3421. Government and export packers. Designers and packers of aircraft equipment.

Middleton Sheet Metal Co., Ltd., Spring Vale Works, Middleton, Manchester. T.: Middleton 2427-8. Navigators' tables and seats.

Parnall (Yate), Ltd., The Aerodrome, Yate, nr. Bristol. T.: Chipping Sodbury 3231. Components armaments, etc.

Power Jets (Research and Development), Ltd., 25 Green St., London, W.1. T.: Mayfair 7801. Management of gas-turbine patents; technical consultants.

Rumbold, L. A., and Co., Ltd., Kingsgate Pl., Kilburn, London, N.W.6. T.: Maida Vale 7366-7-8. Chairs, multiple seating, bunks, beds, stacking seats, tables, etc., for aircraft; soundproofing, luggage and freight attachments.

Samlesbury Engineering, Ltd., Samlesbury Airfield, nr. Blackburn, Lancs. T.: Blackburn 44668. Drawing-office services; airframe and engine overhaul, servicing and maintenance; aircraft seats; packaging, preservation and dispatch.

Test Equipment, Ltd., Gatwick Rd., Crawley, Sussex. T.: Crawley 2350. Wind-tunnel balances, manometers, high- and low-speed models.

Thermotank, Ltd., Helen St., Glasgow, S.W.1. T.: Govan 2444. Plastic and metal punkah louvres.

Transport Seating, Ltd., Western Works, Bromley Street, Birmingham, 9. T.: Victoria 1477 and 1326. Aircraft seats.

10——*Airport Construction and Equipment*

Aerocontacts (Ground Equipment), Ltd., Gatwick Airport, Horley, Surrey. T.: Horley 5511. Airport ground-handling equipment; air-conditioning equipment; wheel chocks, stands and jacks.

Airborne Service Equipment, Ltd., Arterial Rd., Southend-on-Sea, Essex. T.: Eastwood 55265. Aircraft weatherproof covers; portable hangars.

Airfoam Fire Protection, Ltd., 166 Victoria St., London, S.W.1. T.: Victoria 3121. Crash tenders, foam pumps, etc.

Angus, George, and Co., Ltd., Angus House, Newcastle upon Tyne. T.: Newcastle upon Tyne 22656-9. Fire-fighting equipment and protective clothing.

Austinlite, Ltd., Crawley, Sussex. Automatic stand-by generating sets; radar installations.

Aviation Traders, Ltd., 21 Wigmore St., London, W.1. T.: Museum 7791; Southend Airport, Essex. T.: Rochford 56491; and Stansted Airport, Essex. T.: Takeley 391. Hangarage; airport freight-handling equipment.

Bellman Hangars, Ltd., Terminal House, Grosvenor Gardens, London, S.W.1. T.: Sloane 5259. Hangars, large-span buildings and unit construction.

Bolton Gate Co., Ltd., Waterloo St., Bolton, Lancs. T.: Bolton 4240. Bolton top-hung power-operated doors; shutter doors and collapsible gates.

Ceag, Ltd., Queens Rd., Barnsley, Yorks. T.: Barnsley 2208. Aerodrome floodlight lamps.

Central Rediffusion Services, Ltd., Lower Regent St., London, S.W.1. T.: Whitehall 0221 and 8202. Public-address systems and Rediffusion wired broadcasting service for airports.

Chance Brothers, Ltd., Lighthouse Works, Smethwick, 40, Birmingham. T.: West Bromwich 1824. Beacons; emergency generating plant, etc.

Conveyancer Fork Trucks, Ltd., Liverpool Rd., Warrington, Lancs. T.: Warrington 35241. Fork-lift trucks and load-handling equipment.

Cooley Engineering Co., Ltd., Dock Meadow Drive, Lanesfield, Wolverhampton. T.: Bilston 41927-9. Prefabricated hangars, etc.

Costain, Richard, Ltd., 111 Westminster Bridge Road, London, S.E.1. T.: Waterloo 4977. Building and civil-engineering contractors.

Coventry Climax Engines, Ltd., Widdrington Rd., Coventry. T.: Coventry 62607. Fork-lift trucks and trailer fire pumps.

Douglas Equipment, Ltd., Kingsditch Lane, Tewkesbury Road, Cheltenham, Glos. T.: Cheltenham 56361-2-3. Tugmaster aircraft-towing tractors.

Dutton, H. W., and Co., Ltd., 25 Victoria St., London, S.W.1. T.: Abbey 1822. Heating and ventilation.

Esavian, Ltd., Esavian Works, Stevenage, Herts. T.: Stevenage 500. Sliding and folding aluminium doors.

Fire Armour, Ltd., 9 George St., London, W.1. T.: Welbeck 3313. Crash tenders, fire-fighting and rescue vehicles; pumps and ancillary gear. Fognozl equipment.

Hawksley, S. M. D., Ltd., Buckingham Ave., Slough, Bucks. T.: Slough 23212. Aluminium hangars nose docks, etc.

Head Wrightson Aluminium, Ltd., Teesdale Iron Works, Thornaby-on-Tees, Yorks. Light-alloy hangars and aircraft-handling equipment.

Heston Aircraft and Associated Engineers, Ltd., Heston Airport, Hounslow, Middx. T.: Hayes 3844. Passenger steps.

I.T.D., Ltd., 95-99 Ladbroke Grove, London, W.11. T.: Park 8070. Stacatruc and Aerolift fork-lift trucks and Electrical platform trucks; Portapal pallet transporters.

Laing, John, and Sons, Ltd., Bunns Lane, London, N.W.7. T.: Mill Hill 3636. Runways.

Lansing Bagnall, Ltd., Kingsclere Rd., Basingstoke, Hants. T.: Basingstoke 1010. Aircraft handling equipment.

Londex, Ltd., Anerley Works, 207 Anerley Rd., London, S.E.20. T.: Sydenham 6258. Aerodrome signalling equipment, lighting, beacons, etc.

Macks Structures (London), Ltd., Bank Buildings, Waltham Green, London, S.W.6. T.: Fulham 7233. Bellman and blister hangars, Nissen huts and sectional timber buildings.

Mercury Airfield Equipment, Ltd., The Quay, Gloucester. T.: Gloucester 24431-2. Diesel and petrol-engined tractors for towing aircraft and handling baggage; elevating platform trucks for loading aircraft; trailers.

New Welbeck, Ltd., 120 New Bedford Rd., Luton, Beds. T.: Luton 3985. Vacuum cleaners, blowers and sprayers.

Petbow, Ltd., Sandwich, Kent. T.: Sandwich 3311. Aircraft ground-servicing power plant; automatic stand-by generating plant; aircraft starting and towing units.

Red Devon, Ltd., Seymour Wharf, Totnes, S. Devon. T.: Totnes 3282. Aircraft starting units, static and mobile greasing sets.

Ransomes Sims and Jefferies, Ltd., Orwell Works, Ipswich. T.: Ipswich 2201. Aerodrome preparation and maintenance machinery.

Rotorports, Ltd., Kent House, 87 Regent Street, London, W.1. T.: Regent 3524. Developers of helicopter services and city-centre landing sites in U.K. Advisers on heliport design and operation.

Samlesbury Engineering, Ltd., Samlesbury Airfield, nr. Blackburn, Lancs. T.: Blackburn 44668. Hangarage; assembly and maintenance platforms and stagings, etc.

Short and Mason, Ltd., Aneroid Works, 280 Wood St., Walthamstow, London, E.17. T.: Coppermill 2203-4. Wind-speed and direction indicators; special aneroid barometers for control towers.

Siemens Edison Swan, Ltd., 155 Charing Cross Rd., London, W.C.2. T.: Gerrard 8660. Airfield lighting equipment.

Smiths of Stockport, Ltd., 205-207 Wellington Rd. South, Stockport. T.: Stockport 4642. Airborne and ground equipment.

Sparling Motor Bodies, Ltd., Edgware Rd., The Hyde, London, N.W.9. T.: Colindale 7171. Aircraft stairways.

Steel Barrel Co., Ltd., The, Phœnix Works, Uxbridge, Middx. T.: Uxbridge 8535-8. Aircraft fuellers and servicers.

Stone-Chance, Ltd., Crawley, Sussex. T.: Crawley 25251. Aerodrome lighting equipment.

Tannoy, Ltd., 348 Norwood Rd., West Norwood, London, S.E.27. T.: Gipsy Hill 1131. Tannoy equipment and systems.

Transport Equipment (Thornycroft), Ltd., Thornycroft House, Smith Square, London, S.W.1. T.: Abbey 8000. High-performance chassis for crash tenders.

Vosper, Ltd., P.O. Box 18, Portsmouth, Hants. T.: Cosham 79481. Refuelling launches.

Westland Engineers, Ltd., Yeovil, Somerset. Specialized doors and actuating gear.

Williams and James (Engineers), Ltd., Chequers Bridge, Gloucester. T.: Gloucester 24021. Air and oil-free compressors; two-stage compressors and three-stage sets for aircraft ground servicing.

Wimpey, George and Co., Ltd., Hammersmith Grove, London, W.6. T.: Riverside 2000. Airfield construction.

Y.S.C., Ltd., The, 45-47 Copeland Rd., London, S.E.15. T.: New Cross 6113. Very cartridges, Holt flares.

(*Continued on page* 149)

S.B.A.C.
Flying Display and Exhibition
Stand No. 160

CELLON provide the finish for Bristol Plastic Drop Tanks

These tanks, made from asbestos reinforced phenolic plastic, are finished in accordance with the camouflage scheme of the aircraft to which they are fitted. Aerodynamic performance is important and the smoothness and durability of the finish a vital factor. For this reason Bristol Aircraft Limited rely on Cellon Aircraft Finishes.

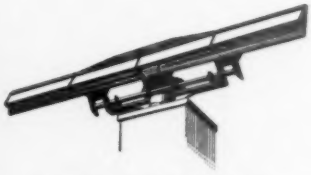
With the march of progress new finishing problems in the aircraft industry are constantly arising but assiduous research enables Cellon to meet the challenge. Specialised resistant finishing schemes are now available for supersonic aircraft, guided missiles and even "flying saucers."

CELLON AIRCRAFT FINISHES

CELLON LIMITED, KINGSTON-ON-THAMES, ENGLAND TELEPHONE: KINGSTON 1234 (9 LINES) TELEGRAMS: "AJAWB, 'PHONE, KINGSTON-ON-THAMES"
ALSO MANUFACTURED IN AUSTRALIA, CANADA, FRANCE, HOLLAND, INDIA & NORWAY

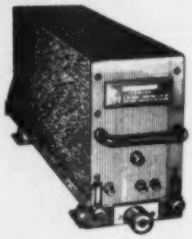
CVS-908

COSSOR

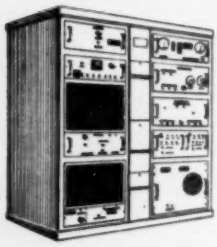


Secondary Surveillance Radar Interrogator-Responsor. The ground equipment of the secondary radar system for Air Traffic Control.

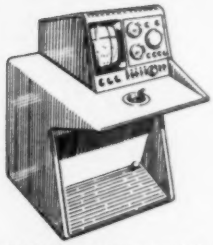
Radar & Electronics Limited



The ATC Airborne Secondary Radar Transponder SSR.1251. Designed to meet I.C.A.O. and ARINC requirements including those for sidelobe suppression.

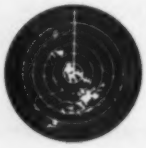


The CR.787 S-Band Airfield Control Radar. A medium range static or mobile primary radar with M.T.I. and circular polarisation.

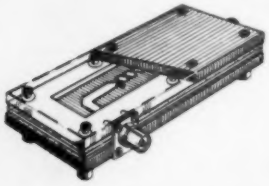


The Windfinding Radar Type 353. A high-performance search and trecking radar for the determination of wind velocities.

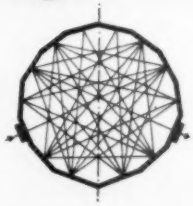
at Farnborough



The C.R.D. 23 ATC Radar Display System. An advanced equipment with full interscan facilities for the P.P.I. presentation of air traffic control information.



Cossor Strip Transmission Lines. A revolutionary advance in microwave engineering.



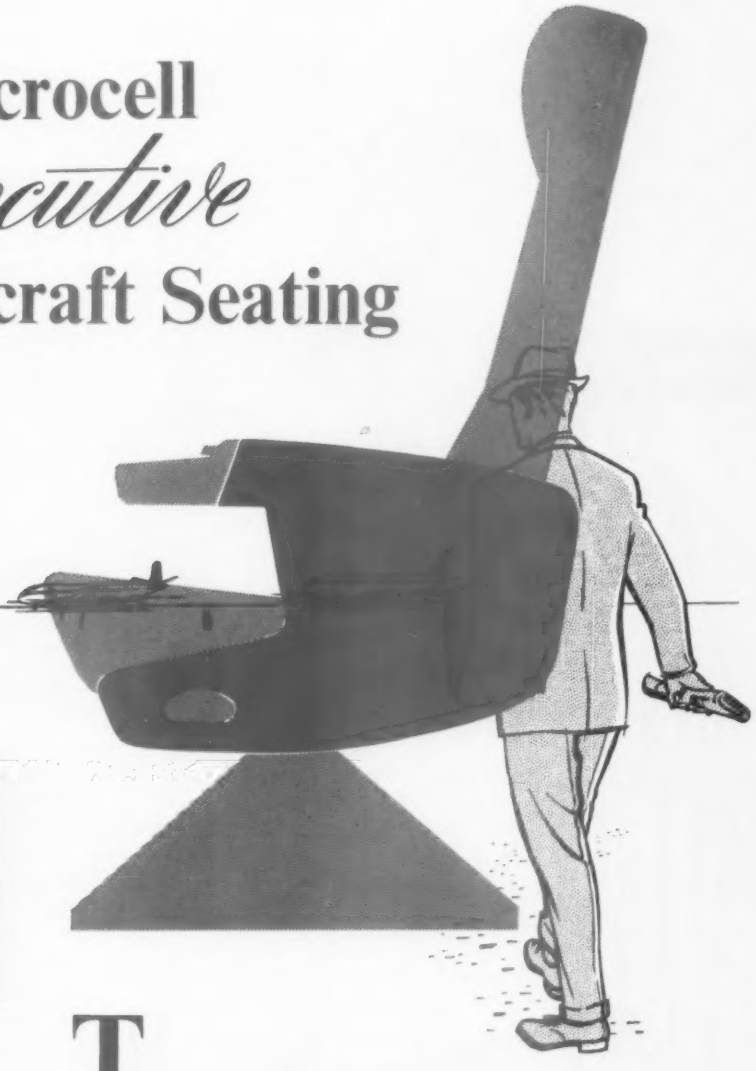
Quartz Delay Lines providing delays of 3 to 2500 μs. At 20 Mc/s centre frequency, the bandwidth is 4½ Mc/s.

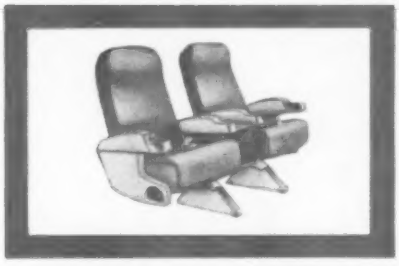
We shall be pleased to discuss these and other products with you on Stand 231

CR 82

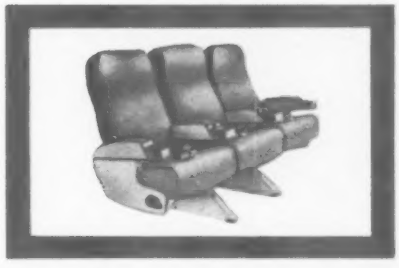
Microcell Executive Aircraft Seating

FOR B·O·A·C FIRST CLASS AND DE-LUXE TRAVEL





DE-LUXE "EXECUTIVE" SEAT.
For special luxury accommodation. This unit is basically similar to the normal twin unit but incorporates a wide contemporary styled cabinet and tray unit, between the two seat places.



EXECUTIVE TRIPLE UNIT AIRCRAFT SEAT
Available also as Twin Unit for forward or aft facing

THE MICROCELL "EXECUTIVE" AIRCRAFT SEAT is unique in combining the simplest possible structure with the fulfilment of all known operational requirements.

This has been accomplished by adopting "Single Beam Unit Construction", an original concept in the use of standardised and therefore readily interchangeable components.

Microcell Limited

A Division of Microcell Limited
9, Kingsway, London, W.C.2
Telephone: Covent Garden 1262

these aren't our words!

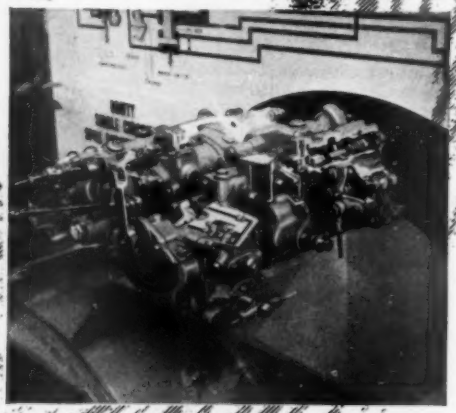
FOUNDRY TRADE JOURNAL NOV. 14 1957

Excellent Aircraft Castings

MORE AND MORE, the showing of superlative examples of the founder's art—in light alloys in particular—is becoming to be associated with the exhibitions connected with the annual Farnborough Air Show. From reports reaching the JOURNAL about the show held this autumn (1957), it is clear that castings of even greater intricacy and versatility were on view this year, a typical example being the case illustrated below. Founders catering for this class of work and exhibiting it so well deserve the congratulations of the whole of the industry, for they certainly set a very high standard.

Dowty single-circuit "spill burner" fuel system incorporates 13 castings in DTD.716 or DTD.722 aluminium—castings made by Sterling.

but they describe our castings

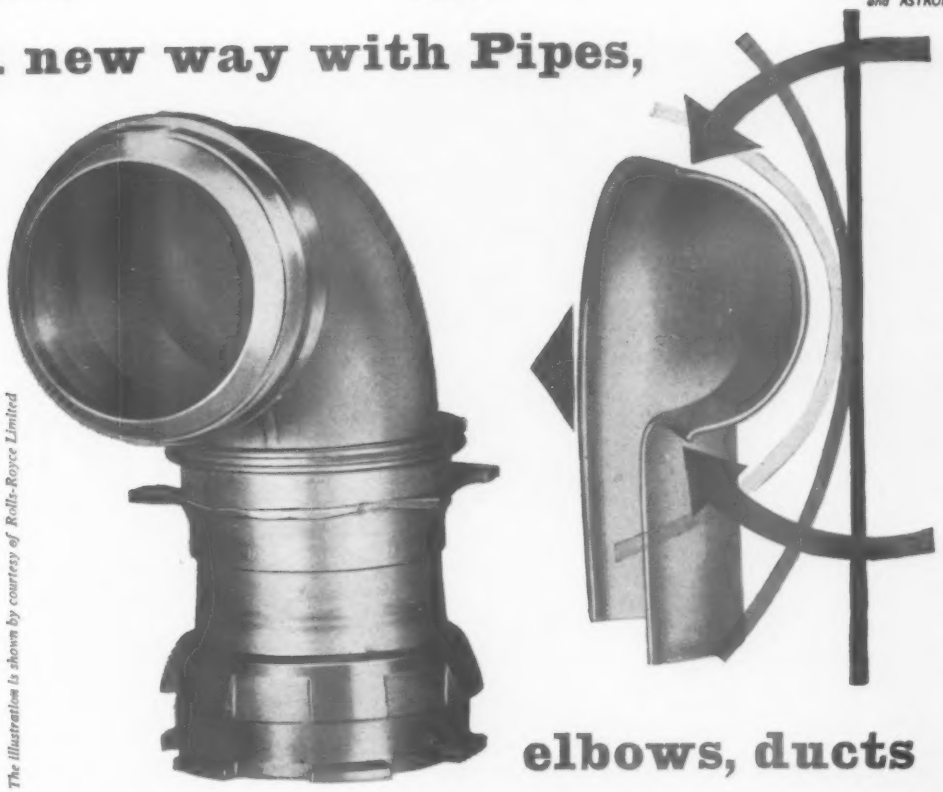


STERMET TRADE MARK

STERLING METALS LTD

NUNEATON · NUNEATON 4284

A new way with Pipes,



The illustration is shown by courtesy of Rolls-Royce Limited

elbows, ducts and valves

Wilmot Breeden, interested in the manipulation of metal in the cold state, have developed, in co-operation with famous jet engine firms, manufacturing methods for systems handling fluids at high and low temperatures.

Pipes, elbows, ducts, valves and bearing housings are formed in nickel-chrome alloys in a succession of press operations from a flat blank. Other processes are rolling, spinning, welding, precision machining and high temperature brazing in atmosphere-controlled furnaces. The method allows for a high degree of accuracy and thus minimises leakage problems. Complex and varied formation can be quickly produced. Pipe bend radii can be kept small in relation to diameters without appreciable variation in wall thickness or change of section. Strict quality control is maintained by our radiological and metallurgical laboratories.

The illustration shows a typical component which forms part of the external anti-icing ducting of the Rolls-Royce Conway engine. This system has metal spherical sealing faces and transmits air at elevated temperatures and pressures with a minimum of leakage.

Elbows and fittings are now being produced by this method in inconel, monel, nickel and stainless steels for the air-conditioning and petro-chemical industries.

If you have an application for this new method we should be pleased to investigate and advise.

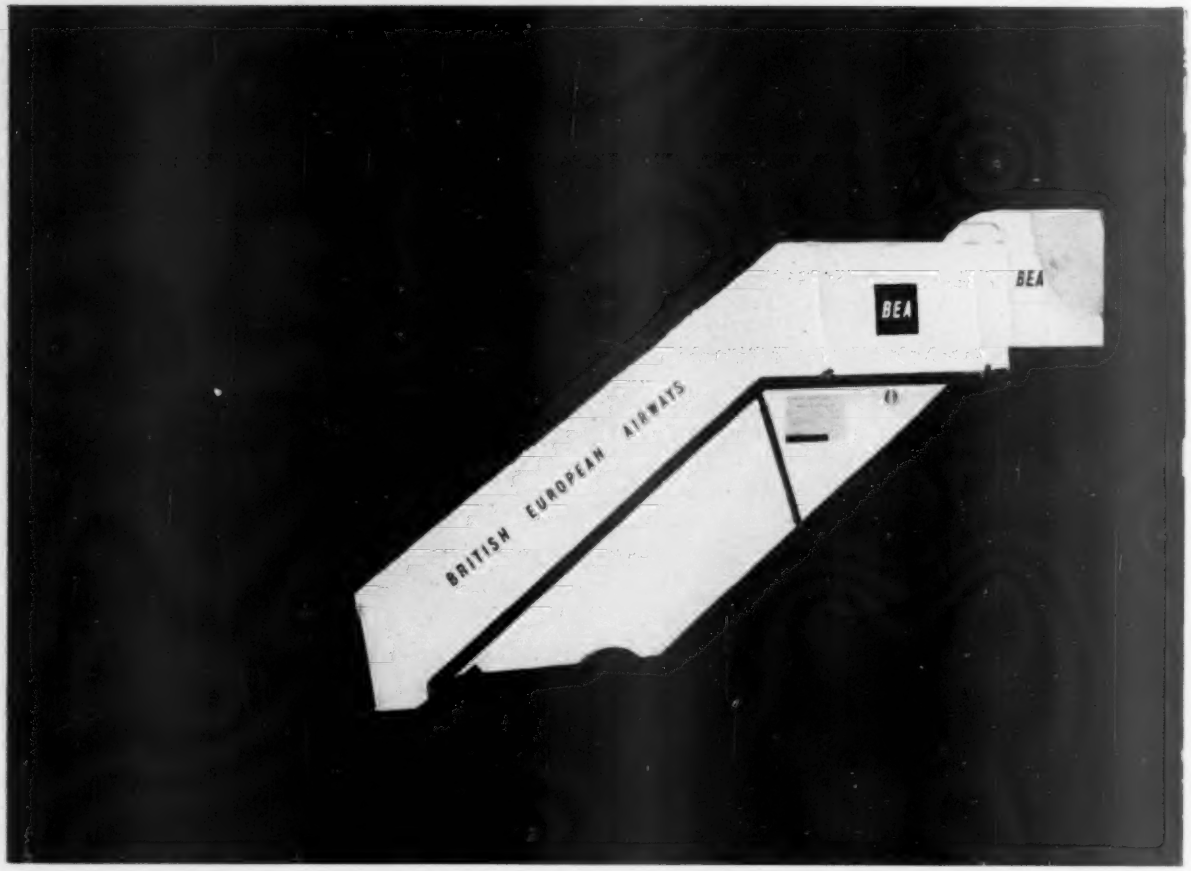
Wilmot Breeden are skilled in metal manipulation

Wilmot Breeden Ltd., Goodman Street, Birmingham, 1

Agents in France .. .. Giltra, Rueil-Malmaison (S & O), France

Agents in Switzerland .. .. Nickel-Contor, Zurich, Switzerland

STAND No. 40
FARNBOROUGH



The Spurling stairway to the Airways

The Spurling passenger steps are completely universal as the height can be easily and quickly adjusted to suit Aircraft such as the Boeing 707, Britannia, Constellation, Comet 4, Convair, DC 4, DC 6, DC 8, Friendship, Stratocruiser, Viscount, Vanguard, Tu 104, etc.

- **Adjustable for use with all types of modern airliners.**
- **Height can be selected visually or can be preset.**
- **Mechanical operation throughout — no hydraulics to be affected by temperature changes.**
- **Can be knocked down for easy transportation.**
- **Full lighting equipment incorporated for all-night services.**
- **Complete stability in windspeeds up to 75 m.p.h.**

ABRIDGED SPECIFICATION

HEIGHT RANGE: 6' 3" to 12' 7½" (upper assembly adjustable in multiples of 7½")

STEP TREADS: 11½"

STEP RISERS: 7½"

STEP WIDTH: 2' 10" (lower assembly) 2' 5" (upper assembly)

WORKING LOAD: 20 average people

GROUND CLEARANCE: (Chassis): 7"

TURNING CIRCLE: 21' 6"

OVERALL WEIGHT: 2450 lbs. approx.

For full details of this and special stairways for Viking, Dakota and Ambassador, contact:

SPURLINGS

SPURLING MOTOR BODIES LTD.

Edgware Road · The Hyde · London . N.W.9 · England
COLindale 7171 Cables: "SPURMOBO" HYDE, LONDON

a vital source of

SAFE POWER

HTP

(HIGH TEST HYDROGEN PEROXIDE)

Visit **STAND 222**
"Live" demonstrations daily

LAPORTE *of course!*

Laporte Chemicals Ltd., Luton *Telephone: Luton 4390*

L I L
A MEMBER OF THE LAPORTE GROUP OF COMPANIES

59

Aluminium and aluminium alloy
plate, sheet, strip, bars, sections, tubes to
British and Overseas specifications

REYNOLDS T.I. ALUMINIUM

LIMITED

General Sales Office: (Home & Export) 10 Buckingham Place, London, S.W.1.

Head Office: Redfern Road, Tyseley, Birmingham 11.

Regional Sales Offices at London, Birmingham, Bristol, Manchester

Leeds, Glasgow, Belfast.

11——*Fuels and Oils*

(*Continued from page 148A*)

Acheson Colloids, Ltd., P.O. Box 12, Prince Rock, Plymouth, Devon. T.: Plymouth 66351. Dispersions of "dag" colloidal graphite and colloidal molybdenum disulphide.

British Oxygen Co., Ltd., The, Bridgewater House, Cleveland Row, London, S.W.1. T.: Whitehall 9777. Liquid-oxygen rocket-fuel oxidant.

Gulf Oil (Great Britain), 6-7 Grosvenor Pl., London, S.W.1. T.: Belgravia 5011. Lubricants and cutting oils.

Laporte Chemicals, Ltd., Luton, Beds. T.: Luton 4390. H.T.P. rocket fuel oxidant.

Mobil Oil Co., Ltd., Caxton House, Westminster, London, S.W.1. T.: Whitehall 1010. Mobilgas and Mobil Diesel; Avrex aircraft engine oils, Mobil Aero fluids, Mobil greases and Mobil industrial and automotive lubricants.

Ragosine Oil Co., Ltd., Minerva Works, Woodlesford, nr. Leeds. T.: Rothwell 2164. Lubricants and extreme viscosity compounds.

Regent Oil Co., Ltd., 117 Park St., London, W.1. T.: Mayfair 8474. Regent and Caltex products.

Sternol, Ltd., Royal London House, Finsbury Sq., London, E.C.2. T.: Monarch 3871. Soluble, straight-cutting, quenching and rust-preventive oils.

Vacuum Oil Co., Ltd., Caxton House, Westminster, London, S.W.1. T.: Whitehall 1010. Mobiloil Aero aero-engine oils, fluids and specialities; Mobilgreases.

Vaughan, Edgar, and Co., Ltd., Legge St., Birmingham, 4. Oils and compounds for metal working, heat-treatment oils and salts.

Wakefield, C. C., and Co., Ltd., Castrol House, Marylebone Road, London, N.W.1. T.: Hunter 4455. Aero lubricants; Castrol and Castrol-aero oils and greases.

12——*Paints, Cleaners and Finishing Processes*

Acorn Anodising Co., Ltd., Durham Rd., Borcham Wood, Herts. T.: Elstree 3116. Anodizers.

Alumilite and Alzak, Ltd., Station Rd., Merton Abbey, London, S.W.19. T.: Liberty 7641. Anodizing, electro-brightening, chemical brightening, etc.

Bennett (Hyde), Ltd., Boston Mills, Hyde, Cheshire. T.: Hyde 1377-9. Gunk D.P. solution and H.S. hydro-seal decarbonizing compound; degreasants.

Berk, F. W., and Co., Ltd., Brent Crescent, North Circular Rd., London, N.W.10. T.: Elgar 3533. Abrasives; building-up equipment; metal spraying and equipment, etc. Schori process.

Fletcher Miller, Ltd., Alma Mills, Hyde, Cheshire. Flick casing oil; Rodol rust preventives; Solvex degreasing compound; liquid Solvex cleaning agent.

Goddard, J., and Sons, Ltd., Nelson St., Leicester. T.: Leicester 23978. Plastic and aluminium polish; lapping media.

Northey Rotary Compressors, Ltd., 200-202 Alder Rd., Parkstone, Poole, Dorset. T.: Parkstone 4900. Oil-free compressors for electro-plating, metal finishing, polishing and spray-painting plants.

Paint Removers, Ltd., York House, Queens Sq., London, W.C.1. T.: Chancery 6877. Paint removers.

Parkes, L. B., and Co., Ltd., 16 Station St., Walsall. T.: Walsall 4546. Anodizing, cadmium plating, Parkerizing and general metal finishing.

Rozalex, Ltd., 10 Norfolk St., Manchester, 2. T.: Blackfriars 1122. Rozalex anti-dermatitis barrier creams and dispensers.

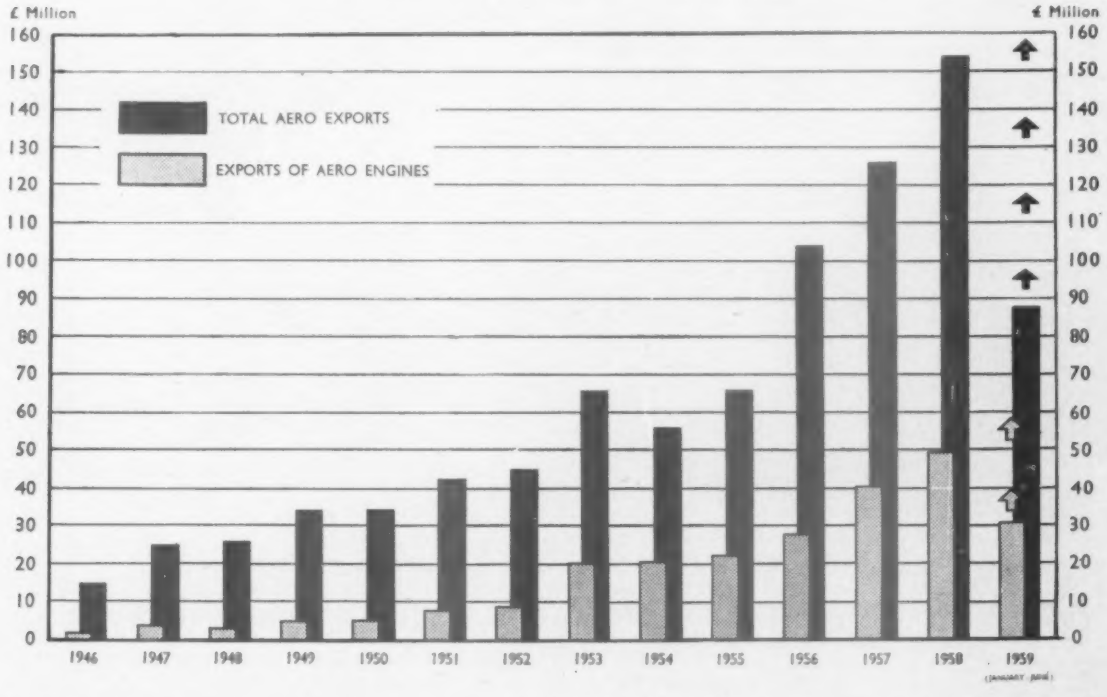
Sternol, Ltd., Royal London House, Finsbury Square, London, E.C.2. T.: Monarch 3871. Barrier creams and hand cleansers.

Union Oxide and Chemical Co., Ltd., Durster House, 37 Mincing Lane, E.C.3. T.: Mansion House 8021. Chromic acid.

Walterisation Co., Ltd., Waddon Marsh Way, Purley Way, Croydon, Surrey. T.: Croydon 2791. Metal-finishing processes; phosphate paint-bonding and rust-proofing treatments. Rust removers and solvents. Alkaline-chromatic oxidation process.

Young, A. S., and Co., Ltd., Tower Works, Woodside Lane, N. Finchley, London, N.12. T.: Hillside 6606-7. Hard-surfacing process for landing skids, arrester gear, etc.

British Aircraft Industry Exports



UP AND UP.—Since 1945, the Aircraft Industry has exported almost £900 million-worth of its products, of which aero-engine manufacturers have accounted for £250 million-worth, or 28.6%. Of the total, more than half (52½%) has been earned during the past 3½ years.

The June figure, £15,102,965, brought the total for the first six months of 1959 to a record £87,804,776 which represented nearly £3½ million a week, or £5 11s. every second of the day and night. This was an increase of 14% over the previous six-monthly record set during July/December, 1958, and represented an annual figure of £175 million compared with last year's record £154 million.

British aero-engines today power more than 50 types of foreign aircraft and in addition to those exported several types of engines, built under licence abroad, have earned many millions of pounds in royalty payments.

ZWICKY

Still lead the way in

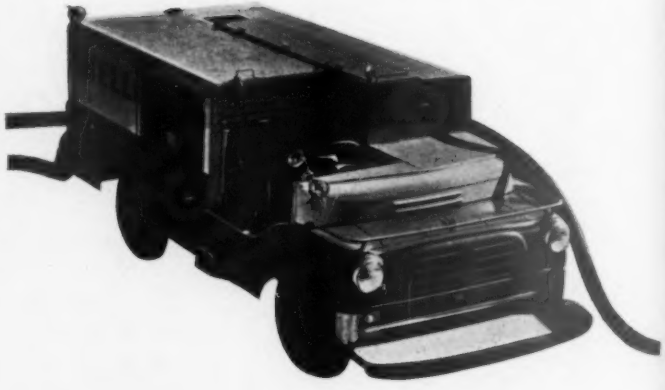
RUNWAY SWEEPER/COLLECTOR

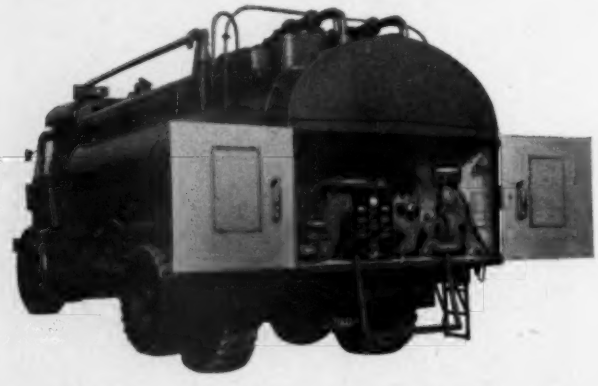
A large number of Runway Sweeper/Collectors are currently being used by Civil and Military Authorities on aerodromes at home and overseas. The cleanliness of runways has become of paramount importance with the introduction of jet aircraft with their high cost of turbine repair. The *Zwicky* vehicle has been designed specifically for this purpose.

It is capable of sweeping over 650,000 sq. ft. per hour and can be completely controlled from the driver's cab by one operator.

'TAGUS' AVIATION HYDRANT DISPENSER

Mounted on *Bedford* CAZ 10/15 cwt. chassis equipped with 2 delivery circuits to pressure refuel underwing at either high or medium flow rates. Capacity 650 g.p.m. with pressure loss of 50 p.s.i. across circuit excluding couplings. This unit has been designed to meet the requirements of the large Jet Engine Air-liners now coming into service throughout the world, i.e.: *BOEING* 707, *D.C.*8, *COMET*, etc.





DUAL PURPOSE REFUELLER

This 2,500 gall. Unit is the standard R.A.F. Refueller and is mounted on a *Leyland* "Hippo" Chassis. Capable of open line fuelling through booms at 200 g.p.m. Pressure refuelling at 500 g.p.m. through electric rewind hose reels, defuelling at 150 g.p.m. and self-loading at 400 g.p.m. This vehicle is also capable of refuelling at 500 g.p.m. from an outside source.

GIVE GENEROUSLY

R.A.F. BENEVOLENT FUND 67 PORTLAND PLACE LONDON, W.1.

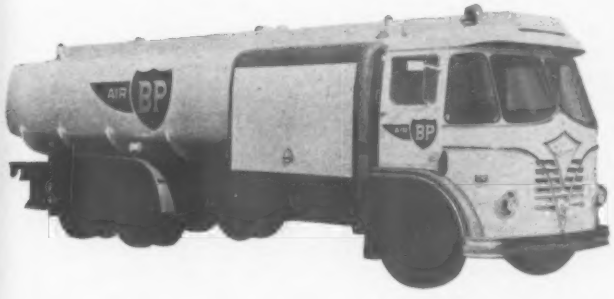
ZWICKY LIMITED are currently manufacturing refuelling units up to 10,000 gall. capacity. Also hydrant dispensers capable of refuelling up to 750 g.p.m. All these refuelling units incorporate Zwicky pressure controllers which are currently being manufactured as by-pass and restrictor types up to 6" bore size, and other proprietary equipment.

ZWICKY LIMITED

Aerodrome Ground Equipment

'SEVERN' 10,000 GALLON SUPER REFUELLER

This is an articulated vehicle, is capable of refuelling at 750 g.p.m. and is equipped with two hydraulic rewind hose reels. A unique feature of this vehicle is the very high weight of product to unladen weight ratio. The actual figure 2.221/1, comparing favourably with other refuellers generally 1/1 or less.



HERTFORD REFUELLER

Where a higher capacity refueller is called for, the HERTFORD takes pride of place. Brief specification details are: 3,630 gall. capacity—two hose reels suitable for either 150 g.p.m. through each 100 ft. of 2" bore hose or 250 g.p.m. through each 60 ft. of 2½" bore hose or 100 ft. of 2½" collapsible hose. Alternative open line refuelling rate of 120 g.p.m. through each line. Defuel rate 50 g.p.m. Hoses power rewound by hydraulic motors. Provision for bottom loading. *Foden* Chassis.

CLYDE REFUELLER

No other Refueller of comparable capacity (1,650 gall.) offers such advantages in efficiency and dependability as the CLYDE. Specification, in brief: Two hose-reels suitable for either 150 g.p.m. through each 100 ft. of 2" bore hose, or 200 g.p.m. through each 75 ft. of 2½" bore hose. Defuel rate 50 g.p.m. Hoses power rewound by hydraulic motors. Provision for bottom loading. *Albion Clydesdale* Chassis.

Visit Stand H (Outside Equipment Display)

and see the following: *10,000 Super Refueller*
'Tagus' Hydrant Dispenser *Super Jet Hydrant Dispenser*

SLOUGH Telephone: SLOUGH 21201-5
Telegrams: SWIKLIM, SLOUGH

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AIRCRAFT FUEL SYSTEM EQUIPMENT

"Flylex" FUEL HOSE

Saves up to 50% in weight

Flylex Flexible Hose Assemblies

Flylex hose, which has a weight-saving factor of up to 50%. Flylex end fittings incorporate redesigned ferrules which further improve anchorage and weight-saving factors. Flylex hose is also being used as fuel-tight electrical conduits.

STAND 260
S.B.A.C.
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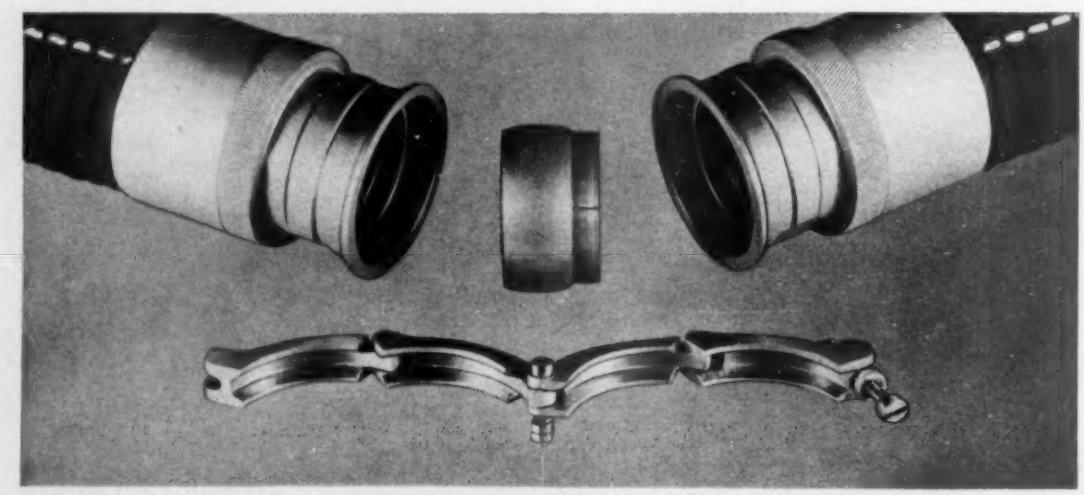
FARNBOROUGH
SEPT. 7-13

Flylite "Flyclamp" Couplings

Designed for easy assembly—an all-metal coupling eliminating jointing material, therefore is unaffected by climatic conditions. Quick assembly—designed for easy installations in inaccessible positions. Used in conjunction with "*Flylite*" Series hose, ensures the perfect installation. Approved for the range of bore sizes 1" to 3" inclusive for use with both "*Flylite*" No. 1 and No. 4 Hose for standard aircraft fuels, namely AVTAR, AVTAG, AVGAS and AVCAT, as well as Methanol water.



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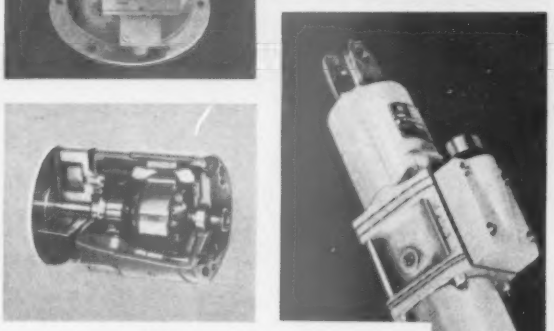

Western's service to the Industry ranges from the supply of aircraft accessory equipment to the manufacture of aircraft fuselages and airframe structures. Whatever the problem, Electrical or Electronic, Pneumatic or Hydraulic, Thermal or Mechanical, Western's have the experience and facilities to solve it. In the field of sub-contract manufacture Western's are privileged to serve the most important aircraft companies. Meet the Western engineers at

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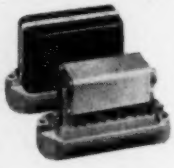
Aircraft Relays

Hendrey Relays have found general acceptance throughout the Aircraft Industry as being of first class design and workmanship. All types can be E.I.D. or A.R.B. released as required.

NEW RELAY TYPE 20B

Modern replacement for '5' and '10B' Series. Improved performance with wiping contacts. Ratings up to 10 amps, 4 pole changeover; or up to 25 amps, 2 pole changeover. Interchangeable with Type 10B.



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This instrument has a voltage output from each axis with resolution better than 0.5%. It is designed for use at flying speeds up to Mach 3 and has a maximum angular movement of ±30° on each axis.

ANGULAR ACCELEROMETER TYPE GW.12

Ranges available from ± 10 to ± 1,000 Radecs. Capacity output—Pattern B.1. Inductance output—Pattern B.2.

The full range of Hendrey Aircraft Relays, including the latest developments, will be shown at the

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On Admiralty, Principal Ministries and Post Office Lists, E.I.D. and A.R.B. Design and Inspection approved.

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D.19

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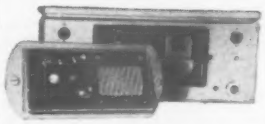
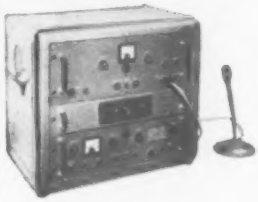
Type 80. With 5 watt mobile for dashboard mounting.

NEW



Type 70. 15 watt mobile for boot mounting.

NEW



Type 400/100. 15 watt fixed station.

NEW

Type 90. 5 watt motorcycle, transmitter/ receiver for tank mounting.

NEW

Type 90 for rear mounting.

These new sets meet the latest channel spacing requirements.

Representative selection of this range of equipment may be seen on STAND No. 281

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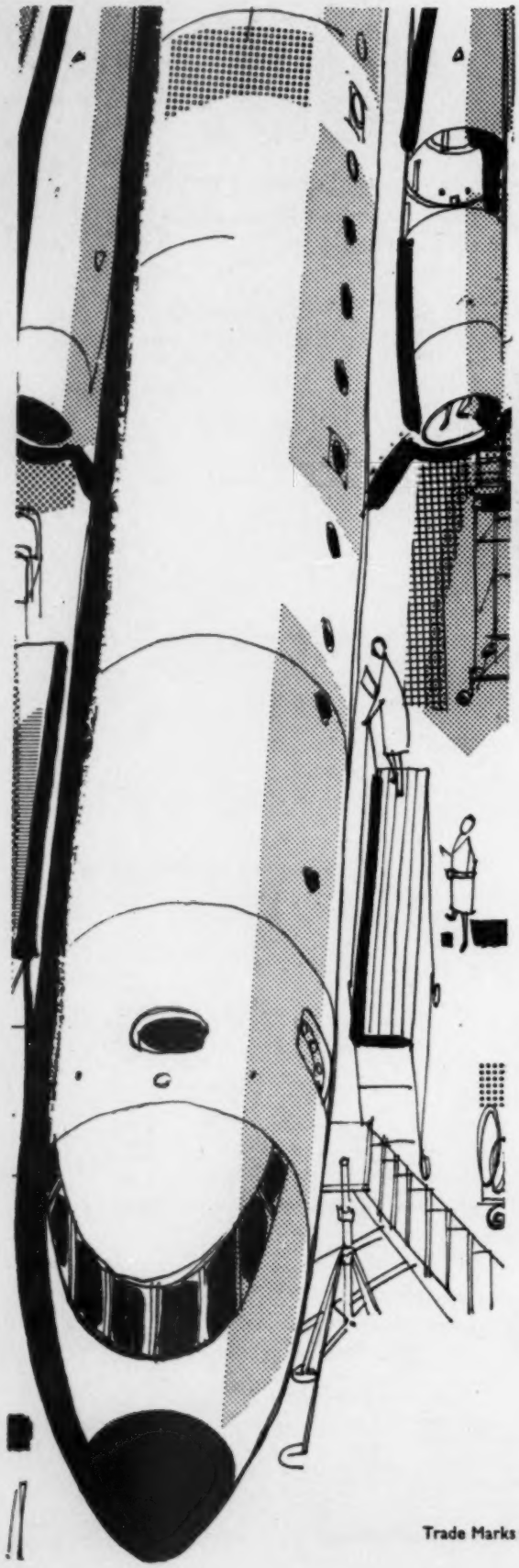

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The Aircraft Industry looks to plastics for many of its vital engineering materials—materials which are used, not only in the aircraft themselves for many thousands of parts including primary surfaces, but also in the fabrication of components for production tooling and assembly.

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* *Bakelite Limited manufacture a wide range of vastly different plastics materials which have an ever extending field of application. Some typical items of interest to many industries are shown in* "BAKELITE *Plastics Review", the current issue of which is now available. Write for a copy.*

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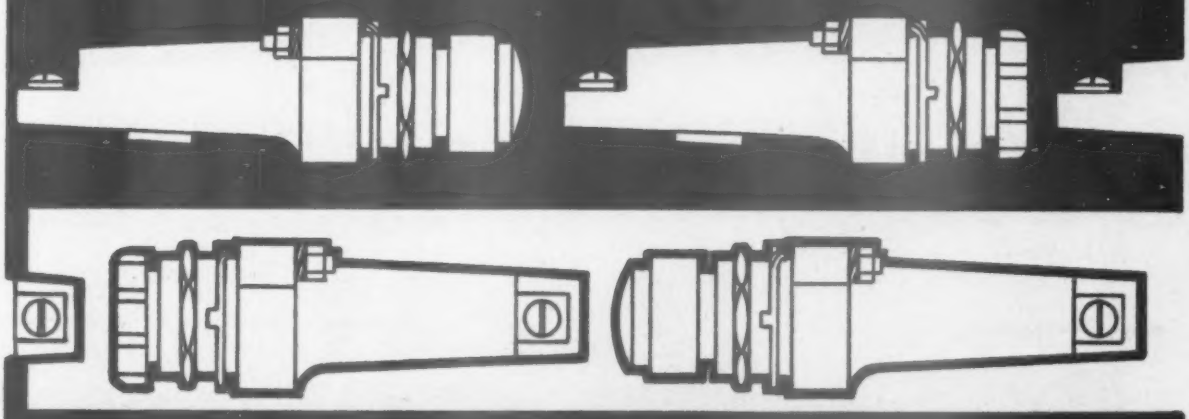

indicating fuse holder

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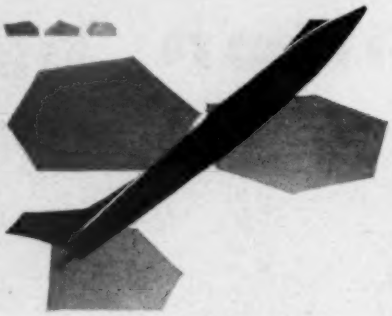

Dramatic weight-reduction in airborne search radar!

EKCO LIGHTWEIGHT SEARCH RADAR

Ekco, first in the world with commercial Airborne Search Radar, now announce yet another major Ekco advance in this field—EKCO Lightweight Search Radar.

This new equipment reduces the total weight to only 56 lbs—less than half that of previous systems! Yet, Ekco Lightweight Search Radar provides all the facilities of a modern Weather Radar System, including a fully-stabilised 24" antenna, 150 mile range and high brightness display.

The reduction in size and number of units, made possible by the extensive use of transistors, allows a consequent saving in installation costs and mounting weight.

These three compact units make up the new Ekco Lightweight Search Radar:
1. Indicator
2. Scanner
3. Transmitter Receiver

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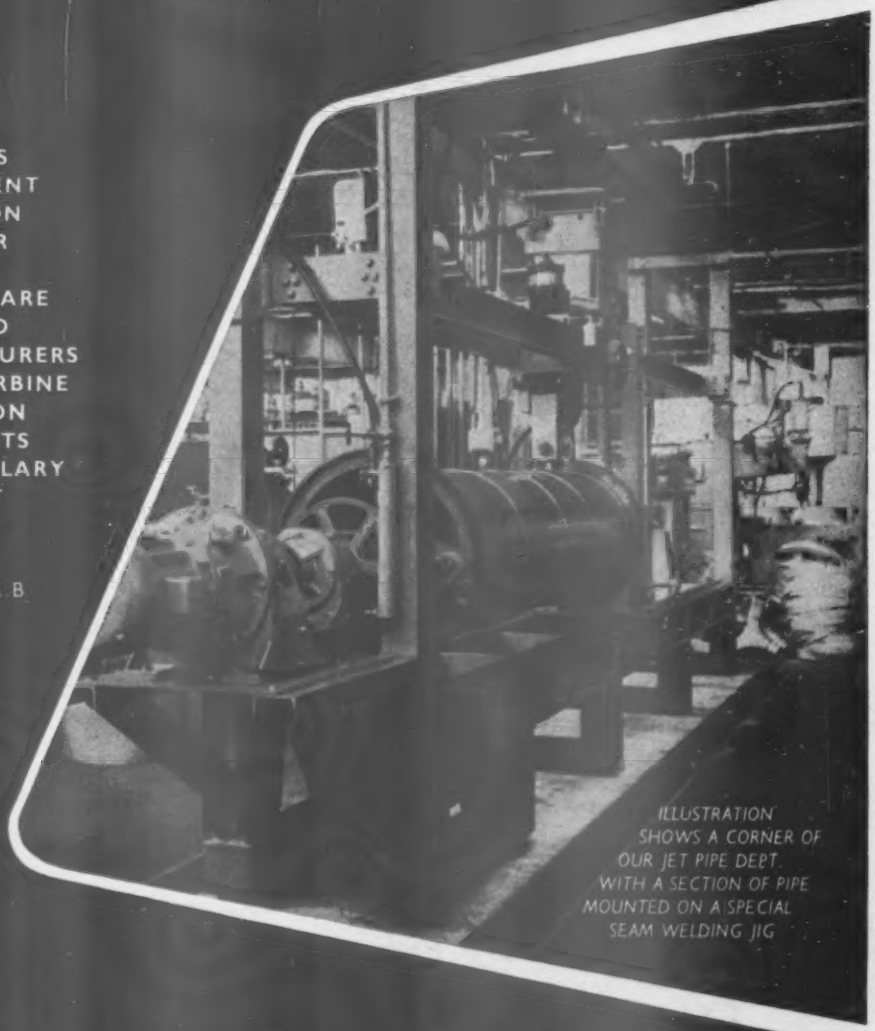

ILLUSTRATION SHOWS A CORNER OF OUR JET PIPE DEPT. WITH A SECTION OF PIPE MOUNTED ON A SPECIAL SEAM WELDING JIG

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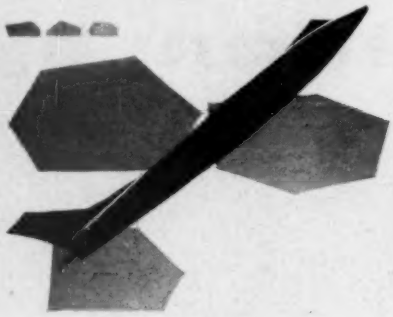

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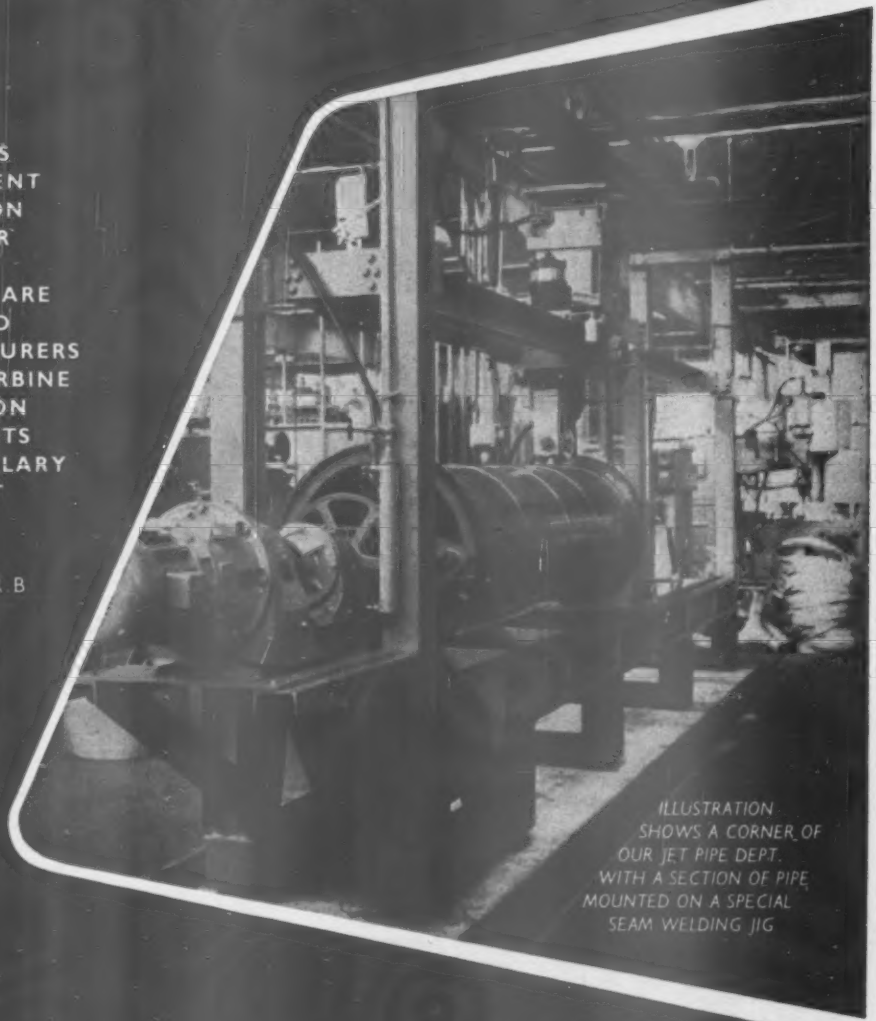

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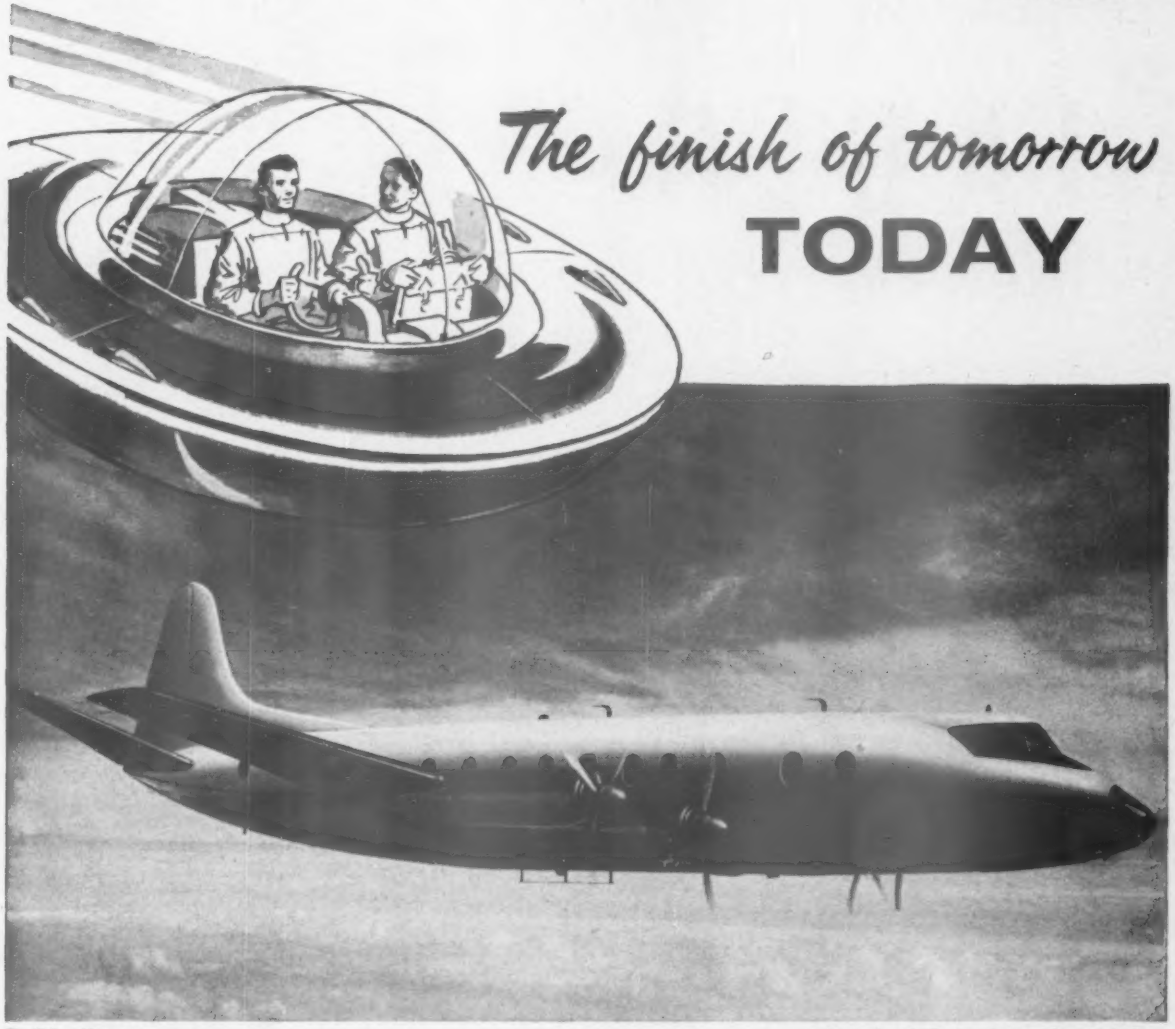

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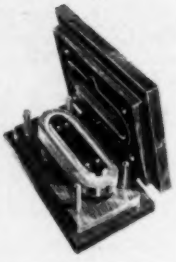

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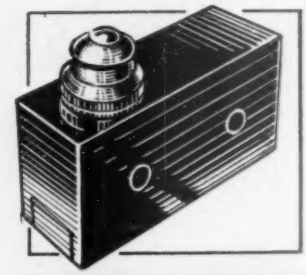

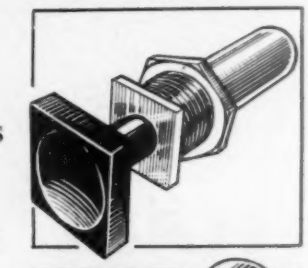

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Its purpose

1. To form a permanent part of the equipment of an aircraft.
2. To make a permanent record of every important parameter throughout the whole life of an aircraft.
3. Through associated playback and an analysis equipment to convert the record to simple tabulated form, from which the state of wear, and the nature of service of every component part can be seen at any time.
4. From this information to allow maintenance schedules to be revised, and provide major economies in aircraft operation with increased safety.
5. To provide the aircraft manufacturer with full information of the actual service which his product has to undergo.
6. To provide a complete record of events leading up to a crash.

Special Features

1. Up to 160 hours duration of record.
2. 0.2% to 1% accuracy.
3. Capacity up to 300 different parameters each sampled every five seconds. Increased sampling rates possible up to 70 per second.
4. The cassette containing the tape can be changed by an unskilled operator in ten seconds.
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1. At x 10 or x 100 the original recording speed.
2. Pre-set Patch Panel system so that the equipment will suit any type of aircraft installation.
3. Automatic analysis of any feature, with graphic display of abnormalities providing automatic editing.

STAND 39

S.B.A.C. Exhibition, Farnborough

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Stand No. 98. **SBAC Exhibition**

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Saturday, 5th September 10 a.m.–1 p.m.
Monday, 7th September 10 a.m.–1 p.m. and 4 p.m.–7.30 p.m.
Tuesday, 8th September 10 a.m.–1 p.m. and 4 p.m.–7.30 p.m.
Saturday, 12th September 10 a.m.–1 p.m.

at the Waldolf Hotel, Aldwych, W.C.2.
TEMPLE BAR 2400

Applicants of degree or H.N.C. standard are sought

Those with previous experience in this field, even without academic qualifications are also invited.

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With the fastest and most simple method of assembly

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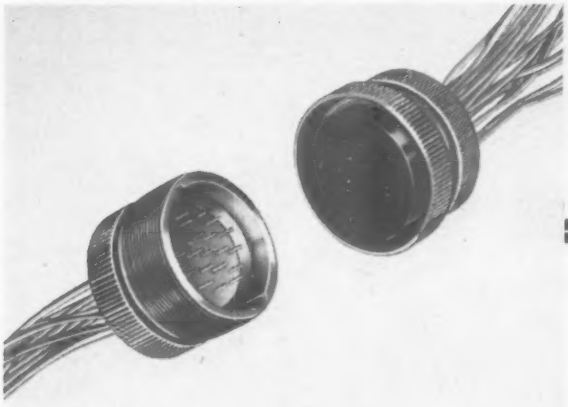

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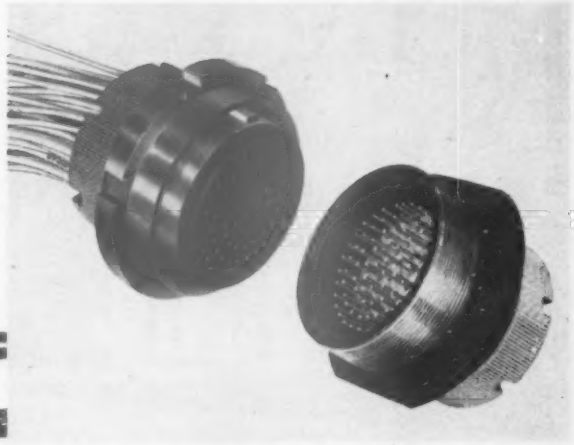

100 way Nyvin 20 cables. Scale ½:1

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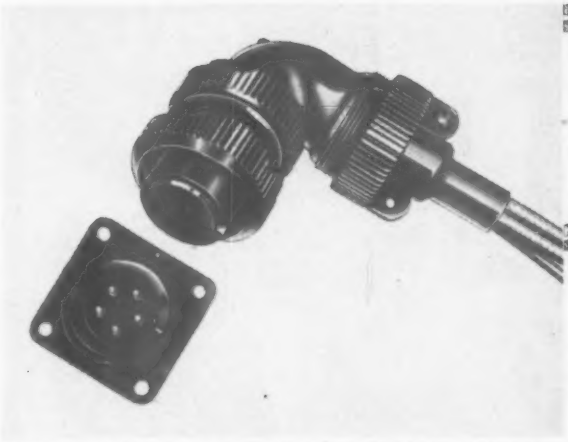

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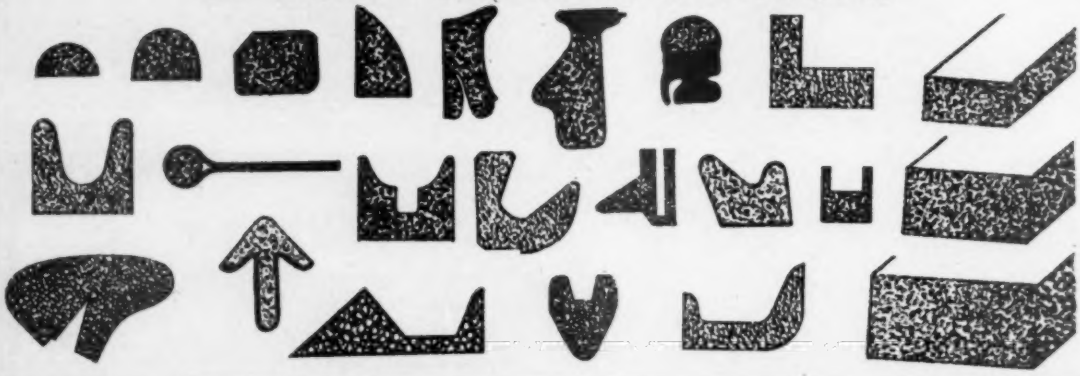

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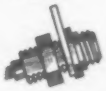

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The "Airfuse" (L.1330) is the British equivalent of the American "Current Limiter" used on 28V.Dc. aircraft power supplies, and has A.R.B. approval. Needing no holder, the "Airfuse" commends itself by its saving in weight and is in use in the "Herald", "Viscount", "Comet", "Stratocruiser" and numerous other famous aircraft.

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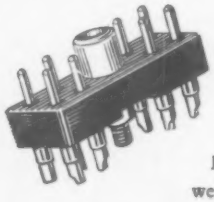

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Bottom right is the high-output MC filter, giving what is for many purposes an acceptable filtration efficiency at a much higher rate than the K type.

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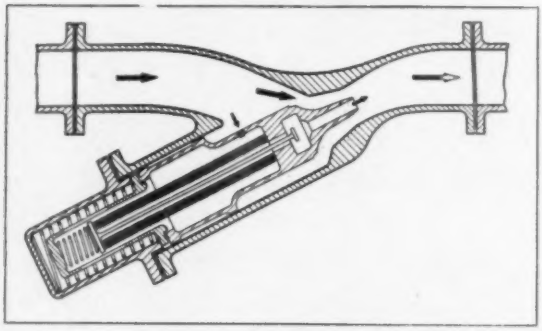

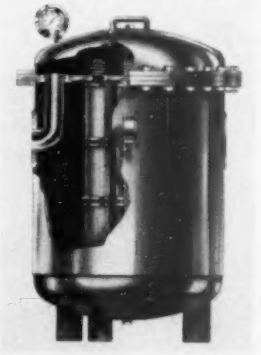

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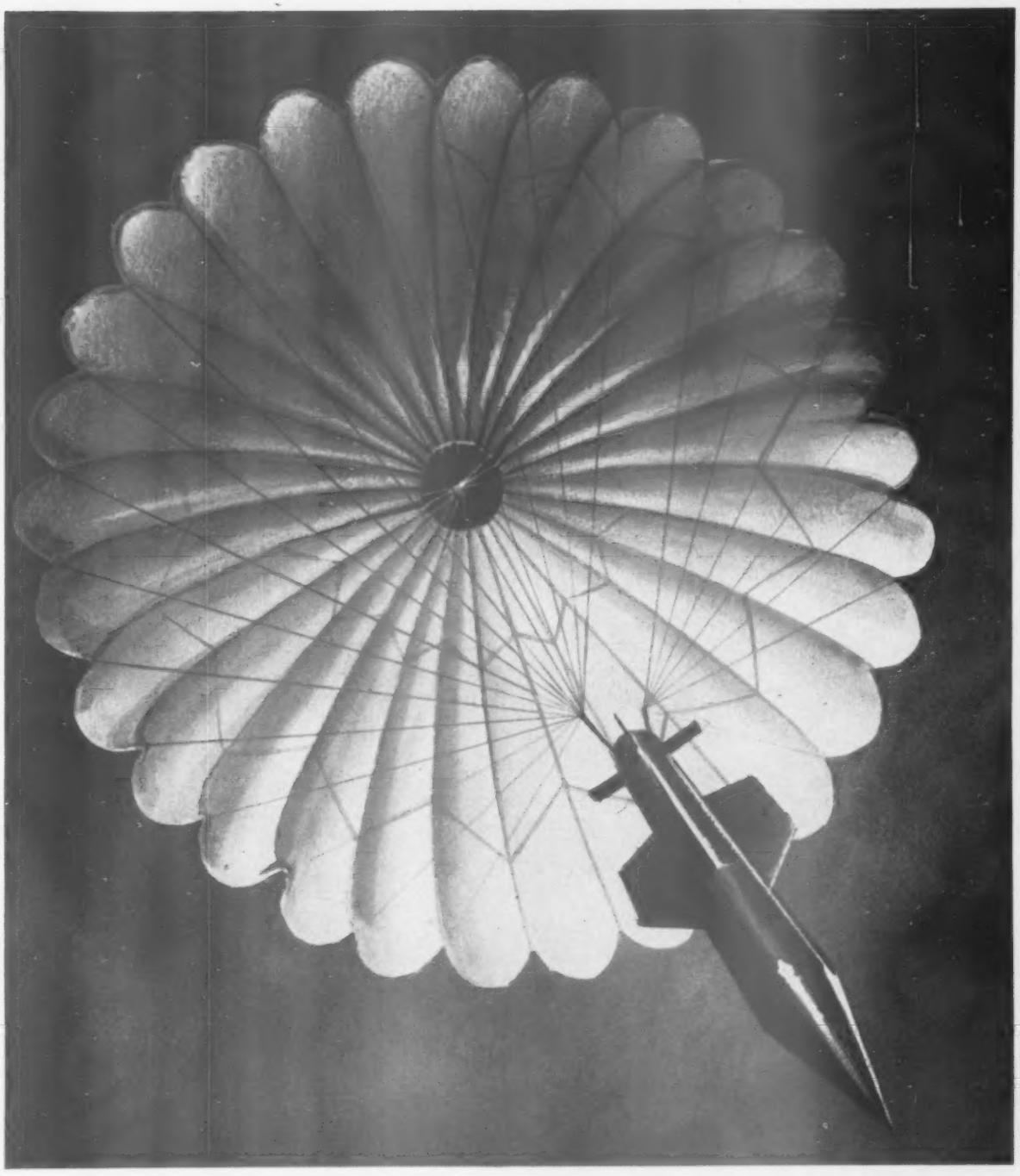

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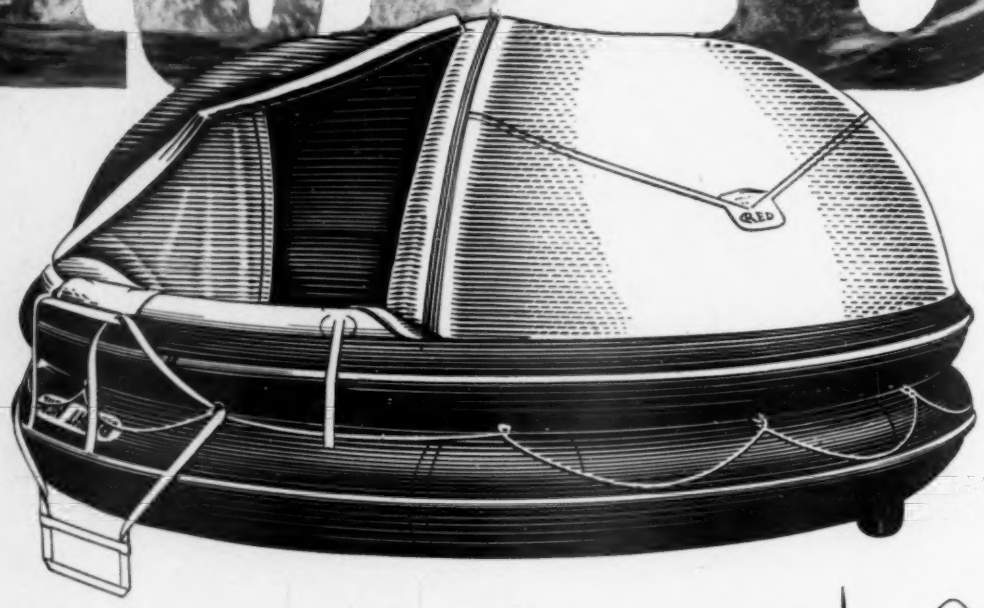

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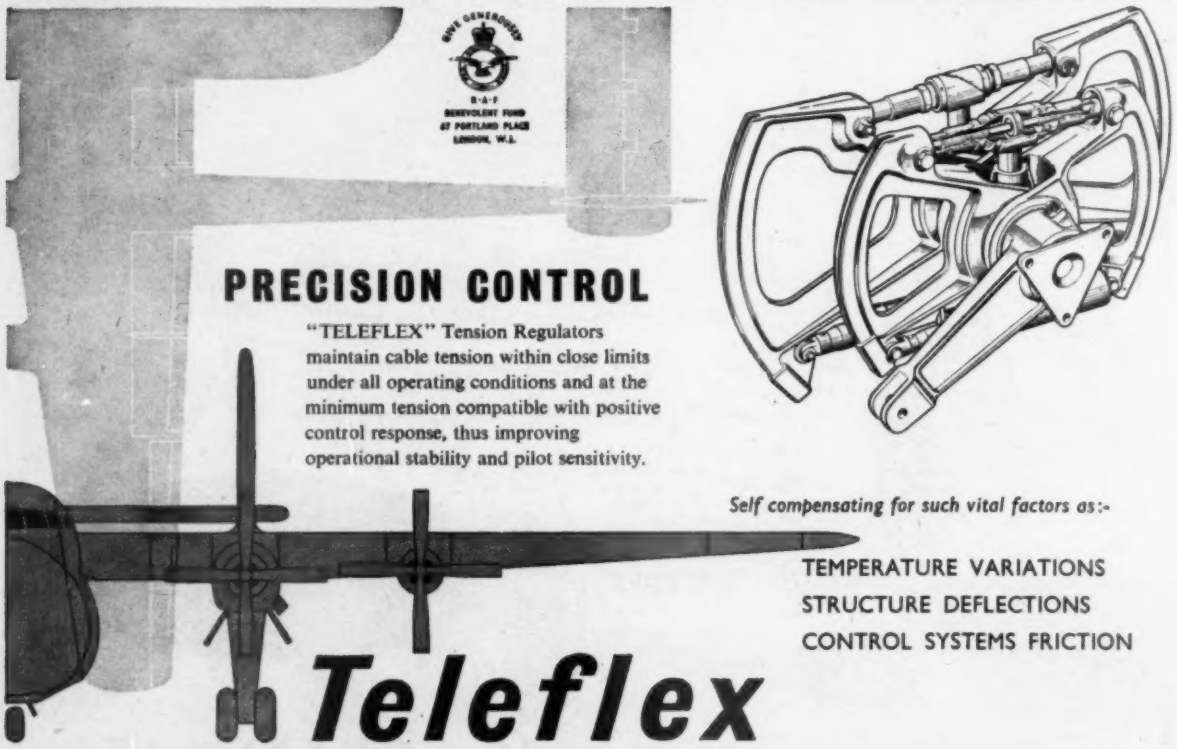

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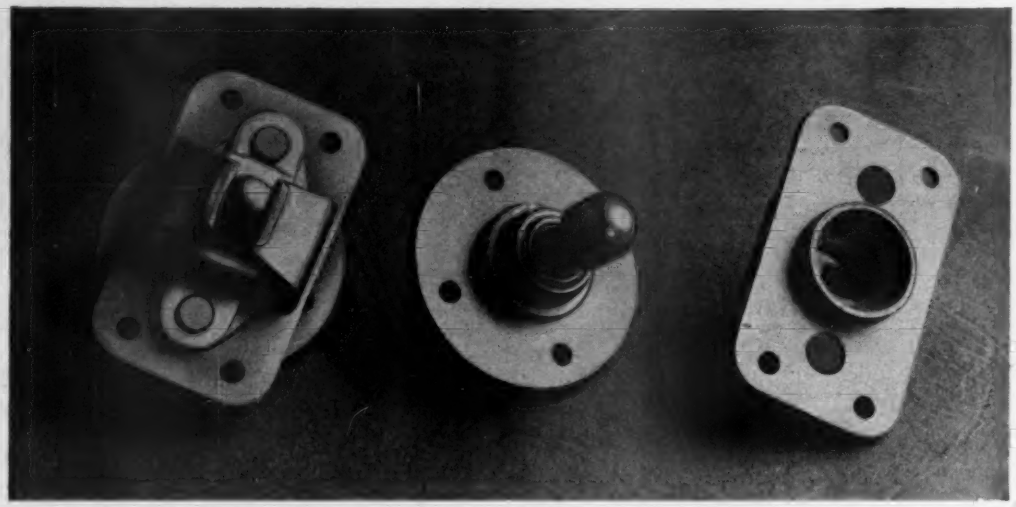

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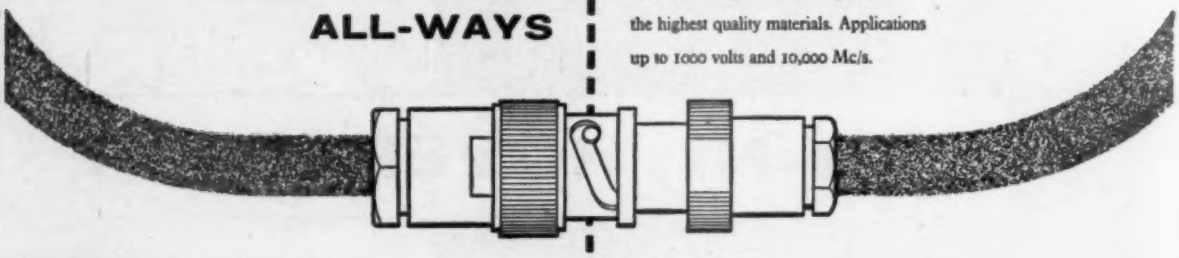

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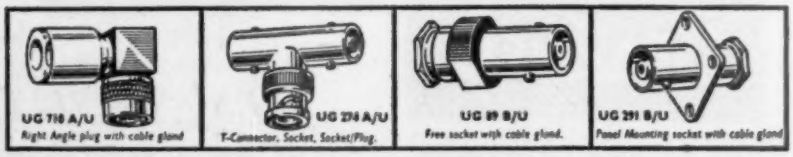
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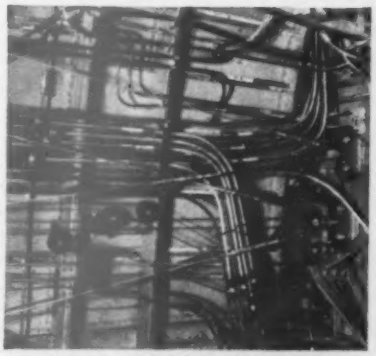

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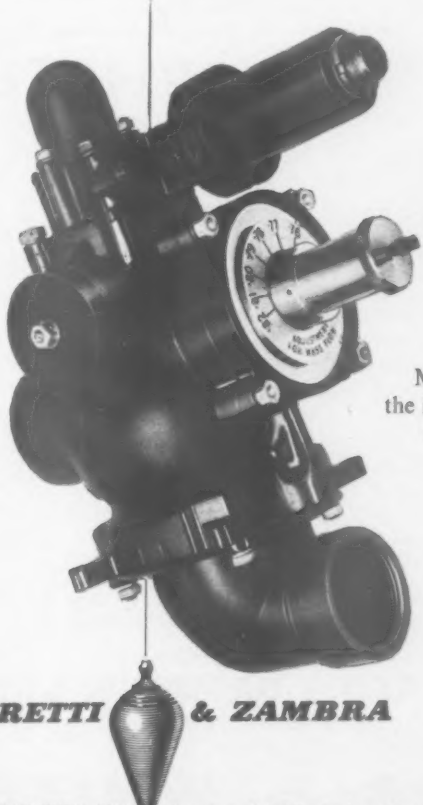

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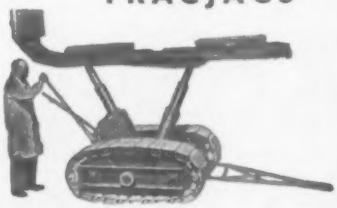

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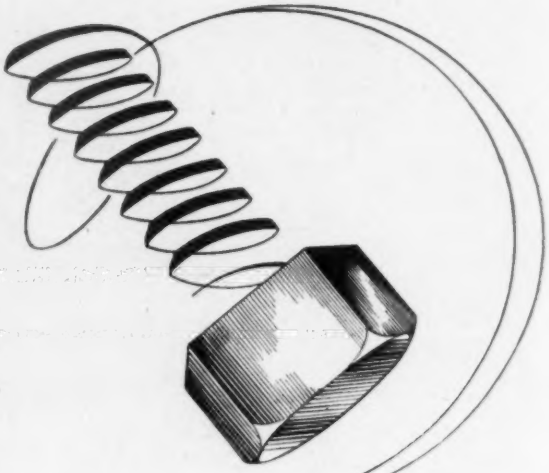

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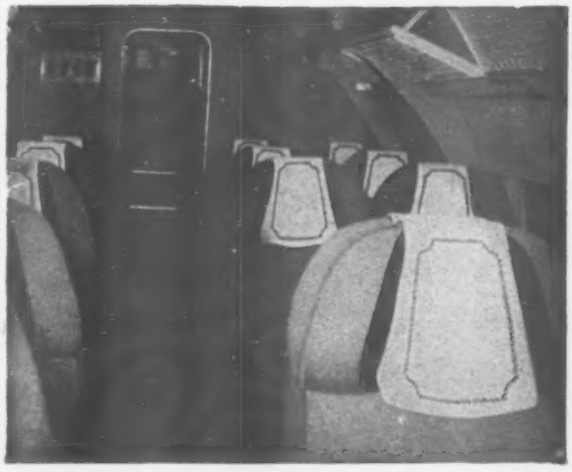

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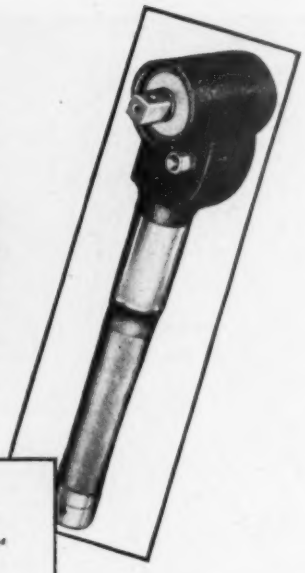

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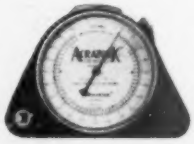

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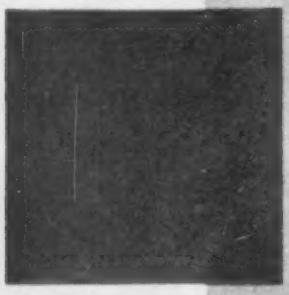

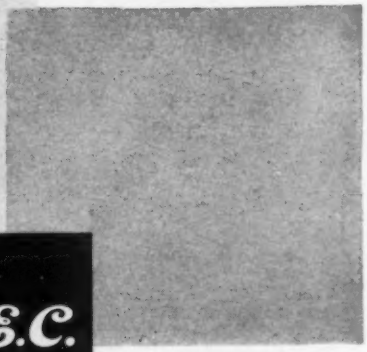

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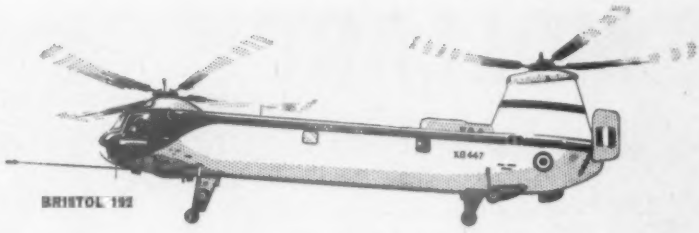
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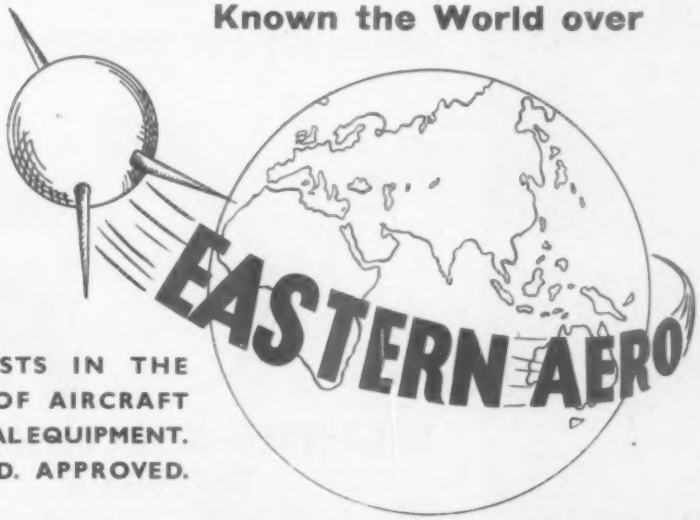

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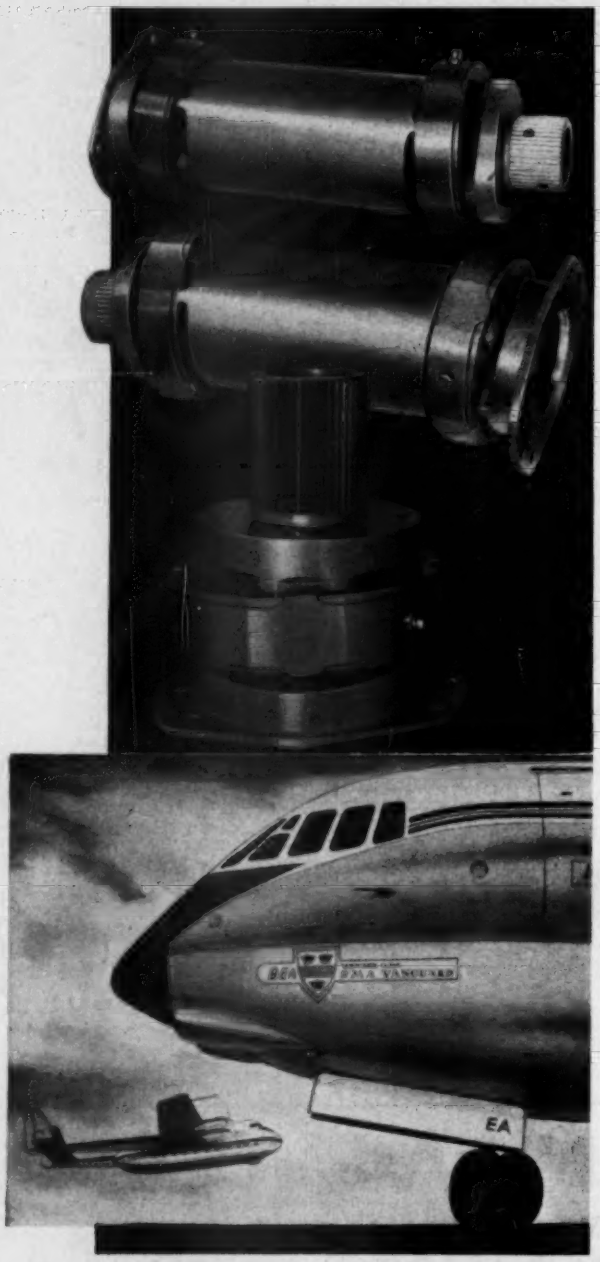

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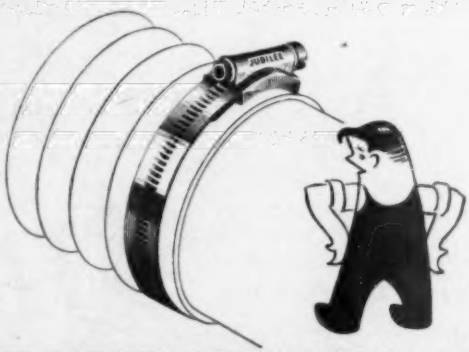

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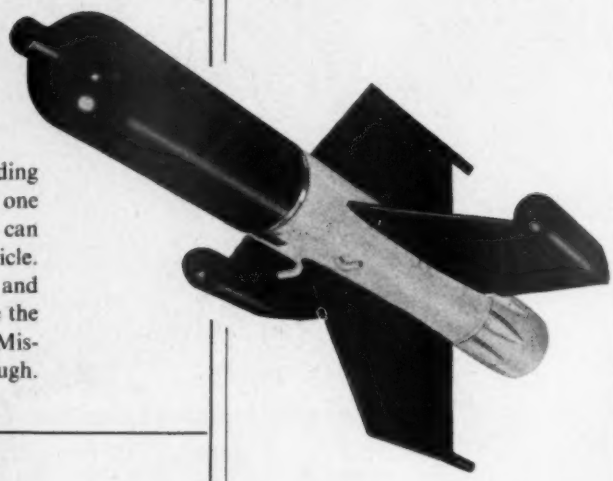

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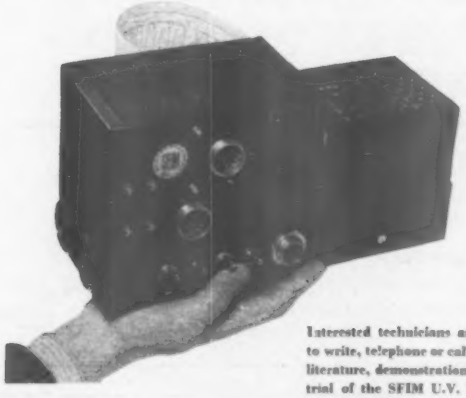

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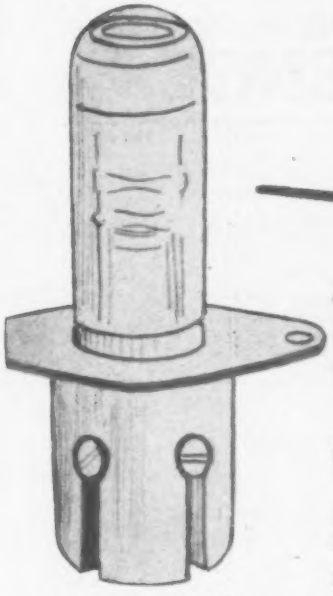

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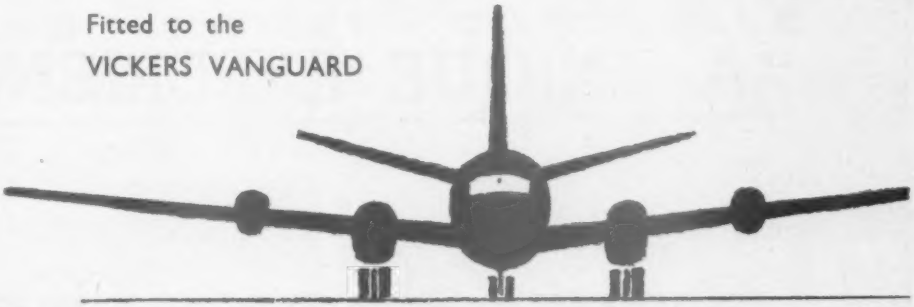

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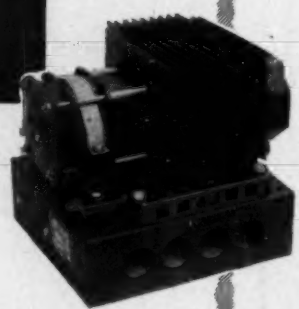

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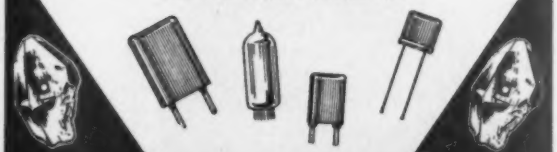

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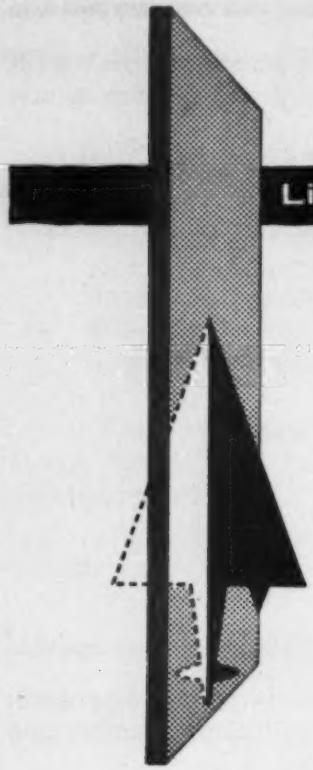

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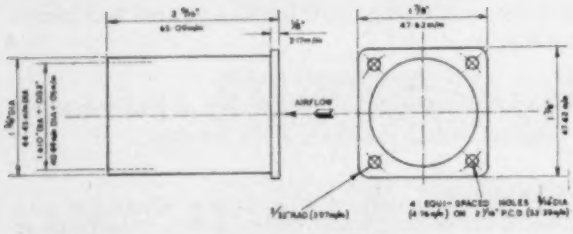

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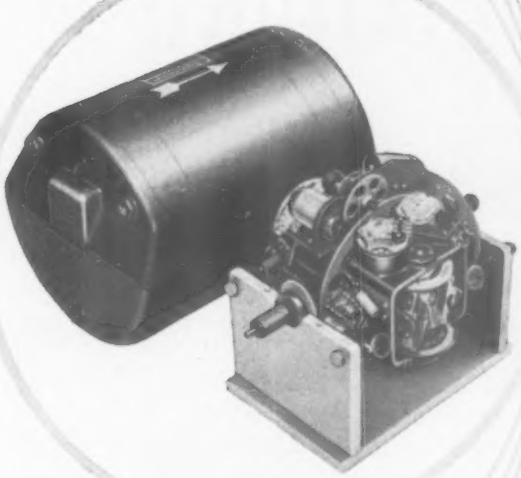

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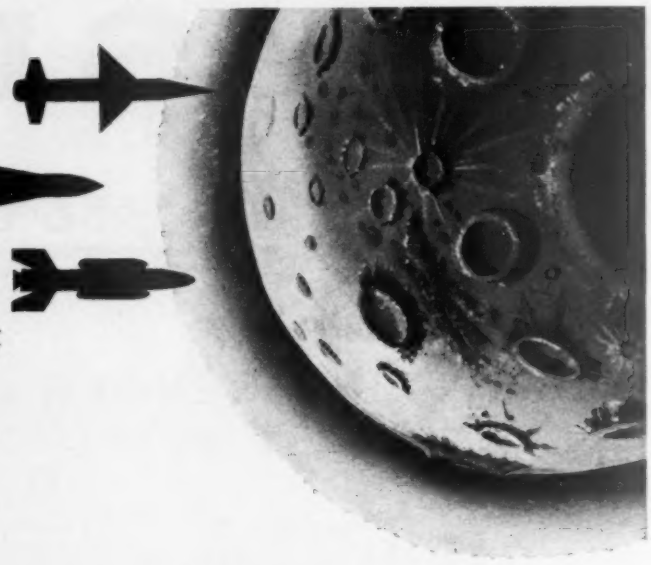

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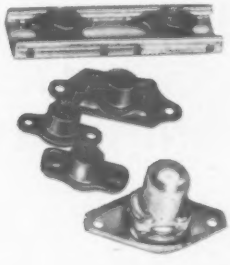

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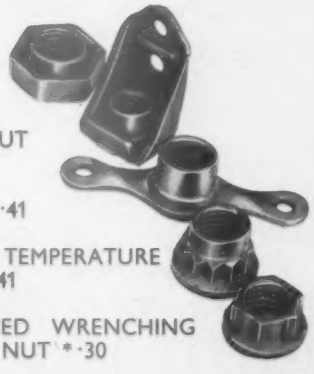

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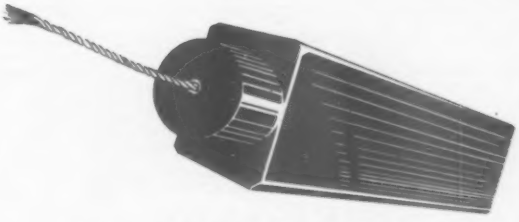

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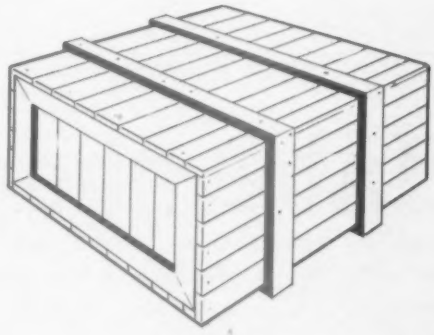

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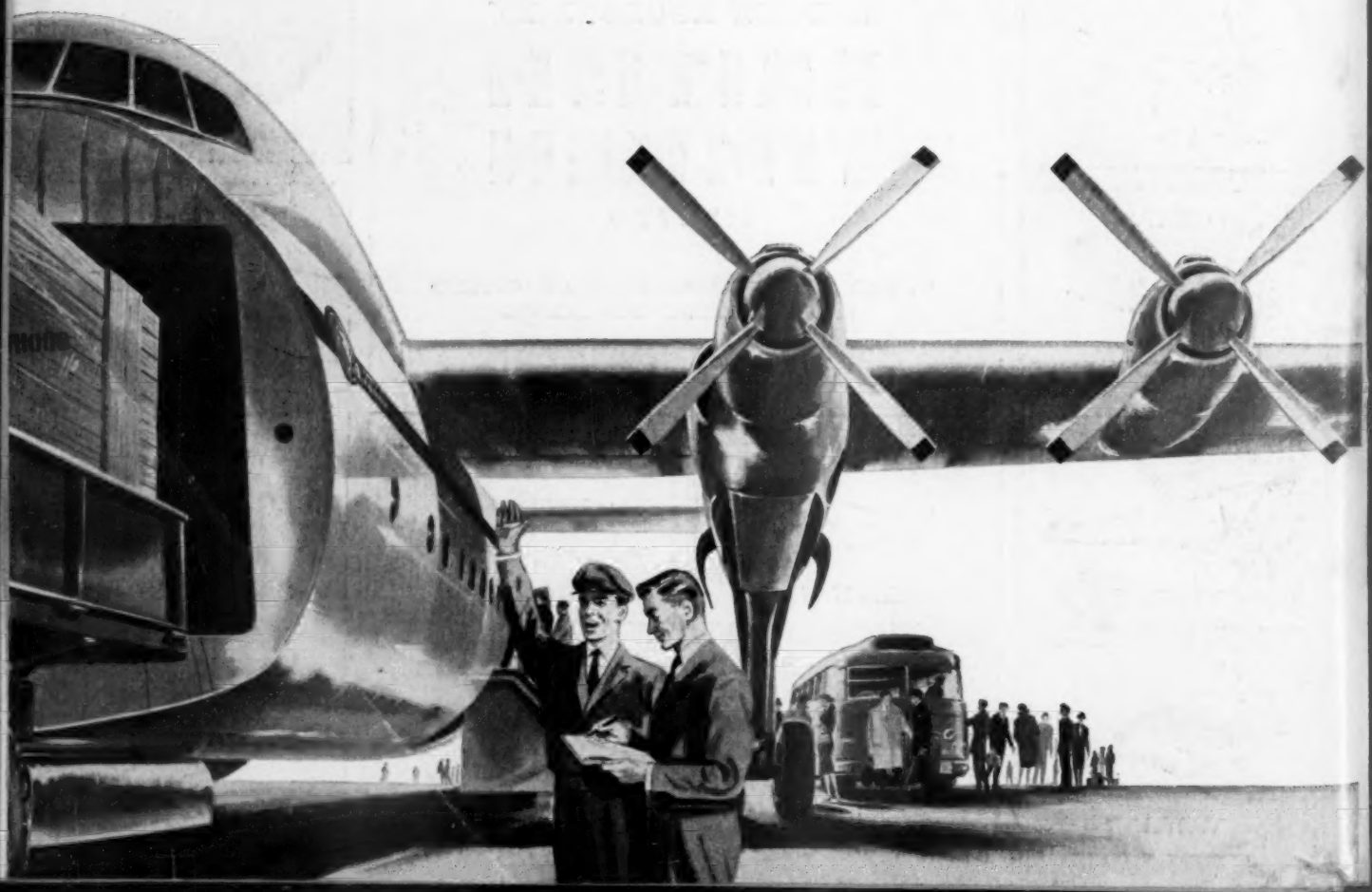
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